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JOHN STUART MILL.

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I.

I PROPOSE to review the life and character of John Stuart Mill. In addition to what all the world may know, I am aided by personal recollections extending over the second half of his life, and by documents in the possession of his family for some of the earlier portions.

My plan requires me to recall the account given in the "Autobiography" of the successive stages of his early education. There is a sort of pause or break at his eighth year, when he began Latin. His years from three to eight are occupied with Greek, English and arithmetic; the Greek, strange to say, taking precedence. His earliest recollection of all, we are led to suppose, although not explicitly affirmed, is his committing to memory lists of Greek words written by his father on cards. He had been told that he was then three years old. Of course reading English, both printed and written, was supposed: and we have to infer that he had no recollection of that first start of all, which must have been taken before he completed his third year. And, judging from the work gone through by his eighth year, he can not be far wrong in putting down the date of the Greek commencement.

A letter from his father to Bentham, dated July 25, 1809, affords us a momentary glimpse of him at the age of three years and two months. It was the occasion of the first visit to Bentham at Barrow Green. The letter is an apology for not being able to come on the day previously arranged, and is full of rather heavy joking about the domestic obstructions. The passage to our present purpose is this:

"When I received your letter on Monday, John, who is so desirous to be your inmate, was in the room, and observed me smiling [at Bentham's fun] as I read it. This excited his curiosity to know what it was about. I said it was Mr. Bentham asking us to go to Barrow Green. He desired to read that. I gave it to him to see what he would say, when he began, as if reading—Why have you not come to Barrow Green, and brought John with you?" The letter closes—"John asks if Monday (the day fixed) is not to-morrow." Not much is to be made of this, except that the child's precocious intellect is equal to a bit of waggery. The remark may seem natural, that if he were then learning his Greek cards he might actually have read the letter; but no one that ever saw Bentham's handwriting would make that remark. As I take it, the interest of the scene lies in disclosing a sunny moment in the habitually stern relationship of the father and son.

As an introduction to the next contemporary landmark of his progress, I need to quote from himself the account of his earliest reading. He says nothing of English books till he has first given a long string of Greek authors—Æsop's Fables, the Anabasis, Cyropædia, and Memorabilia of Xenophon, Herodotus, some of Diogenes Laertius, part of Lucian, two speeches of Isocrates; all these seem to have been gone through before his eighth year. His English reading he does not connect with his Greek, but brings up at another stage of his narrative. From 1810 to 1813 (age, four to seven) the family had their residence in Newington Green, and his father took him out in morning walks in the lanes toward Hornsey, and in those walks he gave his father an account of his reading; the books cited being now histories in English—Robertson, Hume, Gibbon, Watson's Philip the Second and Third (his greatest favorite), Hooke's History of Rome (his favorite after Watson), Rollin in English, Langhorne's Plutarch, Burnet's Own Time, the history in the Annual Register; he goes on, after a remark or two, to add Millar on the English Government, Mosheim, McCrie's Knox, a quantity of voyages and travels—Anson, Cook, etc.; Robinson Crusoe, Arabian Nights, Don Quixote, Miss Edgeworth's Tales, and Brooke's Fool of Quality. I repeat that all this was within the same four years as the Greek list above enumerated. At a later stage, he speaks of his fondness for writing histories; he successively composed a Roman History from Hooke, an abridgment of the Universal History, a History of Holland, and (in his eleventh and twelfth years) a History of the Roman Government. All these, he says, he destroyed. It happens, however, that a lady friend of the family copied and preserved the first of these essays, the Roman History; upon the copy is marked his age, six and a half years, which would be near the termination of the two formidable courses of reading now summarized. The sketch is very short, equal to between two and three of the present printed pages, and gives but a few scraps of the earlier traditions. If it is wonderful for the writer's age, it also shows that his enormous reading had as yet done

little for him. He can make short sentences neatly enough; he gives the heads of the history, in the shape of the succession of kings and consuls; and, in imitation of his author, he supplies erudite and critical notes.[1]

It was about the age when he wrote this history that he was invited to an interview with Lady Spencer (wife of Lord Spencer, then at the head of the Admiralty), her curiosity being roused by the accounts of him. His conversation on the occasion turned chiefly on the personages of Roman history, whose characters he fluently hit off.

My next document is a letter, in his own hand, dated September 13, 1814. He was now eight years and four months. He was in the second stage of his studies, when he had begun Latin, and had extended his reading in Greek to the poets, commencing with the Iliad. He was also teaching his sister, two years younger than himself. The event that gave rise to the letter was the migration of the whole family to Bentham's newly acquired residence, Ford Abbey, in Somersetshire. I will give a part and abridge the rest. His correspondent was some intimate friend of the family unknown.

I have arrived at Ford Abbey without any accident, and am now safely settled there. We are all in good health, except that I have been ill of slight fever for several days, but am now perfectly recovered.

It is time to give you a description of the abbey. There is a little hall and a long cloister, which are reckoned very fine architecture, from the door, and likewise two beautiful rooms, a dining-parlor and a breakfast-parlor adorned with fine drawings within one door; on another side is a large hall, adorned with a gilt ceiling; and beyond it two other rooms, a dining and drawing room, of which the former contains various kinds of musical instruments, and the other is hung with beautiful tapestry.

To this house there are many staircases. The first of them has little remarkable up it, but that three rooms are hung with tapestry, of which one contains a velvet bed, and is therefore called the velvet room. The looking-glass belonging to this room is decorated with nun's lace.

Up another staircase is a large saloon, hung with admirable tapestry, as also a small library. From this saloon issues a long range of rooms, of which one is fitted up in the Chinese style, and another is hung with silk. There is a little further on a room, which, it is said, was once a nursery; though the old farmer Glyde, who lives hard by, called out his sons to hear the novelty of a

[1] The beginning runs thus (heading "First Alban Government: Roman Conquest in Italy): "We know not any part," says Dionysius of Halicarnassus, "of the history of Rome till the Sicilian invasions. Before that time the country had not been entered by any foreign invader. After the expulsion of Sicilians, Iberian (?) kings reigned for several years; but in the time of Latinus, Æneas, son of Venus and Anchises, came to Italy, and established a kingdom there called Albania. He then succeeded Latinus in the government, and engaged in the wars of Italy. The Rutuli, a people living near the sea, and extending along the Numicius up to Lavinium, opposed him. However, Turnus their king was defeated and killed by Æneas. Æneas was killed soon after this. The war continued to be carried on chiefly against the Rutuli, to the time of Romulus, the first king of Rome. By him it was that Rome was built."

child crying in the abbey! which had not happened for the whole time he had lived here, being near thirty years. Down a staircase from here is a long range of bedrooms, generally called the Monks' Walk. From it is a staircase leading into the cloisters. The rest of the house is not worth mentioning. If I was to mention the whole it would tire you exceedingly, as this house is in reality so large that the eight rooms on one floor of the wing which we inhabit, which make not one quarter of even that floor of the whole house, are as many as all the rooms in your house, and considerably larger.

I have been to the parish church which is at Thornecomb. Mr. Hume has been here a great while. Mr. Koe came the other day, and Admiral Chietekoff is expected. Willie and I have had rides in Mr. Hume's curricle.

He goes on to say—"What has been omitted here will be found in a journal which I am writing of this and last year's journeys." He then incontinently plunges again into descriptive particulars about the fish-ponds, the river Axe, the deer-parks, the walks, and Bentham's improvements. The performance is not a favorable specimen of his composition; the handwriting is very scratchy, and barely shows what it became a few years later. The reference to Joseph Hume's visit has to be connected with the passage at arms between the elder Mill and Bentham, which I had formerly occasion to notice ("Mind," viii., pp. 525, 526).

By far the most important record of Mill's early years is his diary during part of his visit to France, in his fifteenth year; and from this I hope to illustrate with some precision the real character of his acquisitions and his intellectual power at that age. A very valuable introduction to this diary was lately brought to light by Mr. Roebuck, who had fortunately preserved a letter of Mill's that he had received from Jeremy Bentham's amanuensis in 1827. It was addressed to Bentham's brother, Sir Samuel Bentham, and it is dated July 30, 1819, his age being thirteen years and two months. The letter begins thus:

My Dear Sir: It is so long since I had the pleasure of seeing you that I have almost forgotten when it was, but I believe it was in the year 1814, the first year we were at Ford Abbey. I am very much obliged to you for your inquiries with respect to my progress in my studies; and as nearly as I can remember, I will endeavor to give an account of them from that year.

He then goes on to detail his reading for the successive years from 1814. I do not print the details, but will compare them with the "Autobiography," and indicate agreements and differences. In the year 1814 (by the letter), he read, in Greek, Thucydides and Anacreon (an odd coupling), and, *he believed*, the Electra of Sophocles, the Phœnissæ of Euripides, the Plutus and the Clouds of Aristophanes, and the Philippics of Demosthenes; in Latin, only the Oration of Cicero for Archias, and part of the pleading against Verres. In Mathematics, he was reading Euclid; he began Euler's Algebra, and worked at Bonnycastle; also some of West's Geometry. In 1815, his reading was Homer's

Odyssey, Theocritus, some of Pindar, the Orations of Æschines and Demosthenes on the Crown. In Latin: first six books of Ovid's Metamorphoses, first five books of Livy, the Bucolics and the first six books of the Æneid of Virgil, and part of Cicero de Oratione. In Mathematics: finished the six books of Euclid together with the Eleventh and Twelfth, and the Geometry of West; studied Simpson's Conic Sections, and West's Conic Sections, Numeration and Spherics; and, in Algebra, Hessy's Algebra and Newton's Universal Arithmetic, in which last he performed all the problems without the book, and most of them without any help from the book.

1816. Greek: part of Polybius, Xenophon's Hellenics, the Ajax and Philoctetes of Sophocles, the Medea of Euripides, the Frogs of Aristophanes, and great part of the Anthologia Græca. Latin: all Horace, except the Epodes. Mathematics: Stewart's Propositiones Geometricæ, Playfair's Trigonometry at the end of his Euclid, "Geometry" in the Edinburgh Encyclopædia, and Simpson's Algebra.

1817. Greek: Thucydides (the second time), many Orations of Demosthenes, all Aristotle's Rhetoric, of which he made a synoptical table. Latin: Lucretius, all but the last book, Cicero, Ad Atticum, Topica, and De Partitione Oratoria. Mathematics: "Conic Sections" in Encyclopædia Britannica; Simpson's Fluxions, Keill's Astronomy, and Robinson's Mechanical Philosophy.

1818. Greek: more of Demosthenes; four first books of Aristotle's Organon, tabulated in the manner of the Rhetoric. Latin: all Tacitus (except the Dialogue on Oratory), great part of Juvenal, beginning of Quintilian. Mathematics: Emerson's Optics, Trigonometry by Professor Wallace, solution of problems, beginning of article on Fluxions in the Edinburgh Encyclopædia. Began to learn Logic, read several Latin treatises—Smith, Brerewood, Du Trieu, part of Burgersdicius, Hobbes.

1819 (the year when the letter was written). Greek: Plato's Gorgias, Protagoras, and Republic. Latin: Quintilian, in course of reading. Mathematics: Fluxions, problems in Simpson's Select Exercises. Also, he is now learning Political Economy.

While this enumeration is much fuller than that in the "Autobiography," it omits mention of several works there given: as Sallust, Terence, Dionysius, and Polybius. The private English reading is in both: chiefly Mitford's Greece, Hooke and Ferguson's Rome, and the Ancient Universal History. His composing Roman History, as well as Poetry and a Tragedy, is given in both. The Higher Mathematics of this period is but slightly given in the "Autobiography."

This letter was doubtless intended not merely to satisfy Sir Samuel's curiosity as to his precocity of acquirement, but also to pave the way for the invitation to accompany him to France the following year (1820).

A carefully written diary, extending over the first five months of

his stay in France, is by far the most satisfactory record that is now to be had of his youthful studies.[1]

We have his reading and all his other occupations recorded day by day, together with occasional reflections and discussions that attest his thinking power at that age. The diary was regularly transmitted to his father. At first he writes in English; but, as one of the purposes of his visiting France was to learn the language, he soon changes to French. Printed in full it would be nearly as long as this article. I shall endeavor to select some of the more illustrative details.

He left London on May 15, 1820, five days before completing his fourteenth year. He traveled in company with Mr. Ensor, an Irish gentleman, a friend of his father's. The diary recounts all the incidents of the journey—the coach to Dover, the passage across, the thirty-three hours in the diligence to Paris. He goes first to a hotel, but, on presenting an introduction by his father to M. Say, he is invited to the house of that distinguished political economist. The family of the Says—an eldest son, Horace Say, a daughter at home, the youngest son, Alfred, at school *en pension*, but coming home on Saturday and Sunday, and their mother—devote themselves to taking him about Paris. He gives his father an account of all the sights, but without much criticism. His moral indignation bursts forth in his account of the Palais Royal, an "immense building belonging to the profligate Duc d'Orleans, who, having ruined himself with debauchery, resolved to let the arcades of his palace to various tradesmen." The Sunday after his arrival (May 21) is so hot that he did not go out, but played at battledore and shuttlecock with Alfred Say. He delivers various messages from his father and Bentham, and contracts new acquaintances, from whom he receives further attentions. The most notable was the Count Berthollet, to whom he took a paper from Bentham. Madame Berthollet showed him her very beautiful garden, and desired him to call on his return; he learned afterward that he was to meet Laplace. On the 27th, after nine days' stay in Paris, he bids good-by to Mr. Ensor and the Says, and proceeds on his way to join the Bentham family, then at a chateau belonging to the Marquis de Pompi-

[1] Sir Samuel Bentham, the brother of Jeremy Bentham, was himself a remarkable man. His first service was in the Russian Army, where his soldiering was intermingled with suggestions for improvements of all sorts, and especially mechanical inventions, for which he had a pronounced genius. One of his proposals to the Russian government was the Panopticon prison, of which he was the originator. He came over to England in 1795, and received from our Government the appointment of Superintendent of the Dockyard at Portsmouth, where his talent for invention had scope in the improvement of the navy. He married the daughter of an early friend of his brother, Dr. John Fordyce, a physician in London, called by Bentham "one of the coldest of the cold Scotch"; this lady had the domestic supervision of Mill for more than a year. On retiring from the Dockyard, Sir Samuel bought an estate in the South of France for the sake of a residence there; and this led to his inviting Mill to reside with him, first at Toulouse, and afterward at Montpellier. The family consisted of one son, Mr. George Bentham, the well-known botanist, and three daughters—all older than Mill.

gnan, a few miles from Toulouse. The journey occupies four days, and is not without incident. He makes a blunder in choosing the cabriolet of the diligence, and finds himself in low company. At Orleans, a butcher, with the largest belly he had ever seen, came in and kept incessantly smoking. On the third day he is at Limoges, and breakfasts in company with a good-natured gentleman from the interior; but his own company does not much improve; the butcher leaves, but a very dirty *fille*, with an eruption in her face, keeps up his annoyance. The following day a vacancy occurs in the interior, and he claims it as the passenger of longest standing; a lady contests it with him, and it has to be referred to the *maire;* the retiring passenger, a young *avocat*, pleading his case. He is now in good company, and his account of the successive localities is minute and cheerful.

He arrives at his destination at 2 A. M., the 2d of June, is received by Mr. George Bentham, and meets the family at breakfast. They take him out for a walk, and he does no work that day, but begins a letter to his father. Next day he makes an excursion to Toulouse, spends the night there, and gives up a second day to sight-seeing; there was a great religious procession that day. He makes the acquaintance of a Dr. Russell, resident at Toulouse, with whose family he afterward associates. The following day, the 5th, he sees the Marquis and Madame de Pompignan, the proprietors of the château. On the 6th, he commences work; and now begins our information as to his mode of allocating his time to study. The entry for this day merely sets forth that he got up early; went into the library; read some of Lucian (who is his chief Greek reading for the weeks to follow); also some of Millot, by Mr. George's advice; "learned a French fable by rote"—the beginning of his practice in French. 7th. "Learned a very long fable; wrote over again, with many improvements, my Dialogue, part I." This dialogue frequently comes up, but without further explanation. We must take it as one of his exercises in original composition, perhaps in imitation of the Platonic Dialogues. 8th. Engaged with Mr. G. in arranging the books of the library, which seems to have been set as a task to the boys. "Wrote some of dialogue; learned a very long fable by heart; resolved some problems of West (Algebra); did French exercises (translating and so forth)." 9th. "Breakfasted early and went with Sir S. and Lady Bentham in the carriage to Montauban; took a volume of Racine in my pocket, and read two plays;" remark his reading *pace*. On returning home he reads a comedy of Voltaire. 10th. "Before breakfast, learned another fable, and read some of Virgil. After breakfast, wrote some of my Dialogue, and some French exercises. Wrought some of the Differential Calculus. Read a tragedy of Corneille." 11th. "Learned another fable; finished my Dialogue. If good for nothing beside, it is good as an exercise to my reasoning powers, as well as to my invention, both which it has tried extremely." We may be sure that it aimed at something very high. "Wrote some

French exercises; began to learn an extremely long fable. Read a comedy of Molière, and after dinner a tragedy of Voltaire. Took a short walk by myself out of the pleasure grounds." 12th. "Rose very early. Sir S. B. and Mr. G. went in the carriage to Toulouse. Before breakfast, I wrote some French exercises, read some of Lucian's Hermotimus. Revised part of my Dialogue. After breakfast went with the 'domestique' Piertot to see his Metairie and his little piece of land and help him to gather cherries. After returning I finished the long fable." Then follows an apology for not working at his mathematics; Sir Samuel's books are not unpacked, and in the library of the house he finds chiefly French literature, and hence his readings in Racine, etc. Another tragedy read to-day. 13th. Before breakfast assists Mr. G. in packing. Wrote French exercises, read Voltaire and Molière. It is by the advice of the family that he reads plays, for the sake of dialogue. After dinner, he takes a long walk on the hills behind Pompignan; on his return falls in with the Garde Champêtre, who communicates all about himself and his district. Weather now hot. 14th. Could not get into the library. Walked about the grounds with Mr. G. and one of his sisters; came in and wrote French exercises. Begins a new study—to master the Departments of France. Reads Lucian. 15th. Got up early; began his Livre Statistique of the Departments—chief towns, rivers, populations, etc. Learns by heart the names of the departments and their capital towns. Acting on a suggestion of Lady B., he reads and takes notes of some parts of the Code Napoleon. Meets the Russell family at dinner, and walks with them. 16th. Up early, walked out, reads a tragedy of Voltaire. A mad dog has bitten several persons. More of Code Napoleon; Virgil; French exercises. Here he concludes what is to make his first letter to his father, and appends to the diary a dissertation on the state of French politics; the then exciting topic being the Law of Elections. We are surprised at the quantity of information he has already got together, partly we may suppose from conversations, and partly from newspapers; but he never once mentions reading a newspaper; and his opportunities of conversation are very much restricted by incessant studies. Besides passing politics, illustrated by anecdotes, he has inquired into education, the statistics of population, and the details of the provincial government.

I continue the extracts from the Diary. June 17th. Late in bed, not knowing the time. One of Sir Samuel's daughters has given him Legendre's Geometry, to which he applies himself, at first, for the sake of French mathematical terms. Performs an investigation in the Differential Calculus. A short walk. After dinner, a tragedy of Corneille. 18th. Rose early. Wrote French exercises, and read Voltaire. It is a fête day (Sunday), and the peasants danced in the pleasure grounds before the house. After breakfast, finished exercises, then walked with the family in the grounds. Received from Mr. G. a lecture on Botany (probably the beginning of what became his favorite

recreation). Wrote out the account of his expenditure since leaving Paris, gives the items, amounting to one hundred and forty-eight francs. Describes the peasants' dance. 19th. Rose early. Finished the Hermotimus of Lucian, and yesterday's tragedy; wrote French exercises. After breakfast, assisted in packing up, as the family are leaving the château for a residence in Toulouse. Finds time before dinner for another tragedy of Voltaire. In the evening, took to an article in the Annales de Chimie (his interest in Chemistry being now of four years' standing). 20th. Occupied principally with preparations for leaving. 21st. The house in confusion. Still he does a good stroke of French reading. 22d. In bed till after nine; could not account for it. The confusion is worse confounded; doesn't know what to do about his books; is now debarred from the library. Has taken out his exercise-book from his trunk, and written a considerable portion of exercises. Has added to his Livre Statistique; the Departments are now fully in his head: next topic the course of the Rivers—an occupation when he has nothing else to do. 23d. Rose at three o'clock, to finish packing for departure. As there could be no reading, at five he takes a long country walk to Fronton; gives two pages of the diary to a description of the country and the agriculture. Books being all locked up, he expects to feel ennui for a little time. Writes some of his Livre, converses with two intelligent workmen, gives particulars. After dinner, walks to the village of —— on the Garonne, describes the river itself in the neighborhood. In the evening, being the "Veille de St. Jean," saw the fires lighted up in the district. 24th. Lay in bed purposely late, having nothing to do. M. Le Comte (son of the proprietor) comes in, and politely offers him the key of the library, shows him a book of prints; he also scores a tragedy of Voltaire. As this is the last day before moving to Toulouse, he makes a pause, and dispatches his seven days' diary to his father, accompanied with a short letter in French to R. Doane, Bentham's amanuensis, chiefly personal and gossipy; none of his letters to Mr. Doane take up matters of thought. 25th. Rose at half past two for the journey. He walks out on foot, to be overtaken by a char-à-banc, with part of the family. One of the girls drove part of the way, and gave him the reins for the remainder, as a lesson in driving. They take up their quarters in one of the streets, where they have a very good "Apartment" (I suppose a flat); still, after the château, they feel considerably cramped; his room a little hole, which he proceeds at once to arrange, having got shelves for his books. Same night finishes Lucian's Βίων Πρᾶσις, and reads some of Thomson's Chemistry, which is part of his own library.

The family remains in Toulouse for some time. We have his diary for nearly six weeks. It is the intention of the Benthams to find him, not merely a French master, but instruction in various accomplishments —music, dancing, fencing, horsemanship. It is some time before the arrangements are made, so that his first days are purely devoted to

book studies; and the diary is an exact record of the nature, amount, and duration of his reading, very nearly as at home. It also gives occasional glimpses of his thinking power at the age he has now reached. It is further interesting as exhibiting his tone toward his father. I will merely quote enough to complete the illustration of these various particulars.

26th. Besides a mass of French reading, reports two eclogues of Virgil and the Alectryon of Lucian. Remarks that having so much French to do, he cannot read Latin and Greek and study Mathematics every day, and means to give one day to Mathematics and one to Latin and Greek. 27th. Rose early. Begins the practice of going every morning to bathe in the Garonne, a little above the town: he is accompanied regularly by Mr. George, and on this occasion by Dr. Russell's boys. To-day reads Legendre's Geometry. Gives a subtile criticism of the author's method, which he thinks excellent; praises the derivation of the Axioms from the Definitions, as conforming to Hobbes's doctrine that the science is founded on Definitions. Approves also of the way the more elementary theorems are deduced. Learned a very long French fable. Solved a problem in West's Algebra that had baffled him for several years. Mr. George has already engaged for him the best dancing-master in the place. 28th. (Classical day.) Bathing as usual. Two eclogues of Virgil, and a French grammatical treatise on Pronouns. Read some more of Legendre (resolution broken through already): thinks his line of deduction better than Euclid, or even than West. Studies Bentham's Chrestomathic Tables (a vast and minute scheme of the divisions of knowledge). Began the Vocalium Judicium of Lucian. Goes for a second dancing-lesson. 29th. Rather late in returning from the river. An eclogue of Virgil; finishes the Vocalium Judicium; wrote French exercises, read some of Boileau's little pieces; is to have Voltaire's works soon; asks Mr. George about a Praxis in the higher Mathematics, having performed over and over again all the problems in Lacroix's Differential Calculus. Resolves more problems of West, including the second of two that had long puzzled him. After dinner began Lucian's Cataplus. 30th. Two eclogues of Virgil; finished Cataplus; more of Legendre, discovered a flaw in one of his demonstrations; wrote French exercises; read some of Sanderson's Logic; also some of Thomson's Chemistry. July 1. Treatise on Pronouns finished; Sanderson; began Lucian's Necyomantia; French exercises; finished first book of Legendre; Thomson's Chemistry. Dancing-lesson. A singing-master engaged. 2d. Georgics of Virgil, ninety-nine lines; more of the Necyomantia before breakfast. After breakfast, Thomson's Chemistry. Wrote Livre Geographique. In the evening the whole family go to Franconi's Circus; describes the exploits. Has to be measured for a new suit, French fashion; his English suit being inadmissible, trousers too short, waistcoat too long. The Russells call in the evening, and there is an earnest talk on politics, English and

French, which he details. 3d. A breakdown in the char-à-banc that takes them to the river. Has now got a singing-master, and takes first lesson in *Solfèges et Principes de Musique.* Again at Franconi's, and full of the performance; for a wonder, no studies recorded. 4th. Rose at five; home from bathing, etc., at half past seven. Has obtained Voltaire's Essai sur les Mœurs, which he includes among his stated reading: breakfast at quarter to nine: at half past nine, begins Voltaire where he left off in England, read six chapters in two hours; Virgil's Georgics, forty-seven lines; at quarter past twelve began a treatise on French Adverbs; at half past one began the second book of Legendre, read the definitions and five propositions; miscellaneous employments till three, then took second Music-lesson. Dined; family again to Franconi's, but he could not give up his dancing-lesson; this got, he writes French exercises and practices music. 5th. Rose at five; too rainy for bathing. Five chapters of Voltaire; from half past seven till half past eight Mr. G. corrects his French exercises which had got into arrears as regards correction; Music-master came; at half past nine began new exercises (French); puts his room in order; at quarter past eleven took out Lucian and finished Necyomantia; five propositions of Legendre, renewed expressions of his superiority to all other geometers; practiced Music-lessons; Thomson's Chemistry, made out various Chemical tables, the drift not explained; at quarter past three, tried several propositions in West, and made out two that he had formerly failed in; began a table of fifty-eight rivers in France, to show what departments each passes through, and the chief towns on their banks; four, dined; finishes Chemical table; dancing-lesson; supped. Reports that a distinguished music-mistress is engaged at whose house he is to have instrumental practice. 6th. Rose at six; no bathing; five chapters of Voltaire; a quarter of an hour to West's Problems; lesson in Music (*Principes*); problems resumed; breakfasted, and tried problem again till quarter past ten; French exercises till eleven; began to correct his Dialogue, formerly mentioned, till quarter past twelve; summoned to dress for going out to call; has found a French master; at quarter past one returned and corrected Dialogue till quarter past three; Thomson till four (dinner), resumed till six; Mr. G. corrects his French exercises; went out for his French lesson, but the master did not teach on Sundays and Thursdays; back to Thomson till eight; repeated fables to Mr. G., miscellaneous affairs; supped; journal always written just before going to bed. 7th. Rose forty-five minutes past five; five chapters Voltaire till seven; till quarter past seven, forty-six lines of Virgil; till eight, Lucian's Jupiter Confutatus; goes on a family errand; Music-lesson till nine (*Principes*); Lucian continued till half past nine, and finished after breakfast at quarter past ten; a call required him to dress; read Thomson and made tables till quarter past twelve; seven propositions of Legendre; has him over the coals, for his confusion in regard to ratio "takes away a good deal of my opin-

ion of the merit of the work as an elementary work": till half past one, wrote exercises and various miscellanies; till half past two the treatise on Adverbs; till forty-five minutes past three, Thomson; Livre Geographique and miscellanies till five; eats a little dinner, being uncertain, owing to a family event; goes for first lesson to music-mistress, a lady reduced by the Revolution, and living by her musical talents; henceforth to practice at her house daily from eleven to twelve, and take a lesson in the evening; dined on return, then dancing-lesson. 9th. Rose at five; five chapters Voltaire; forty-five minutes past six, Adverbs; forty-five minutes past seven, the Prometheus of Lucian; half past eight till nine, first lesson of *Solfèges* together with *Principes;* continued Prometheus till breakfast; miscellaneous occupation till the hour of music-lesson at Madame Boulet's; home at half past twelve, ten propositions of Legendre; "if anything could palliate the fault I have noticed of introducing the ratio and the measures of angles before the right place, it is the facility which this method gives to the demonstration of the subsequent propositions; this, however, can not excuse such a palpable logical error, etc." Mr. G. is to procure Cagnioli's Trigonometry, but a Praxis in the higher Mathematics is not yet forthcoming. 10th. Starts at four with Mr. G. and the Russells on a day's excursion to the forest of Bouconne, three leagues from Toulouse, the object being to collect plants and insects. Makes his *coup d'essai* at catching butterflies, got only about ten worth keeping; the adventures of the day fully given. 11th. Yesterday's fatigue keeps him in bed late; one chapter of Voltaire; at half past seven, with Mr. G., to begin with his French master, who hears his pronunciation, and sets him plenty of work. Taken with a party to the house of an astronomer, M. Daubuisson, and shown his instruments; then to the house of his brother, a great mineralogist. Returns at two to commence the formidable course of lessons set by the French master. Goes successively to his music-master and music-mistress. Introduces a remark as to the great kindness of the family in constantly, without ill-humor, explaining to him the defects in his way of conducting himself in society: "I ought to be very thankful." 12th. Hears from his father that Lady B. has written a good account of him. Replies in full to the matters in his father's letter; is glad to hear of his article on Government and promises on his return to read it with great attention. Indicates that in future his French lessons will very much engross his time. He is to take the first opportunity of sending the Dialogue, on which he has taken great pains both with expression and with reasoning. Apologises for giving more time to Mathematics than to Latin and Greek.

A fencing-master is now provided for him, and in two days more a riding-master, so that we may have seen him at his best as regards book studies. He keeps these up a few hours every day, but the largest part of the day is taken up with his other exercises. The only thing deserving mention now is the occasional notice of new subjects. Thus,

he begins a treatise on Value, and Sir S. B. is to get Say's book for him. His French master seems to prescribe, among other things, translating from Latin into French, and he takes up the speech of Catiline in Sallust, and afterward some Odes of Horace. There is another day's excursion to the forest of Ramelle, with many incidents. He soon reports having read the last of Lucian, and gives a short review of him, accompanied with high admiration ; Hermotimus he considers a masterpiece of ingenious reasoning. In a letter to his mother he adverts to his progress in music and dancing; he advises his two elder sisters to remit their music till he returns, as he discovers now that they were on a wrong plan. Writes a letter in Latin to those two sisters, correct enough but not very high composition. Begins a Dialogue at the suggestion of Lady B., on the question—whether great landed estates and great establishments in commerce or manufactures, or small ones, are most conducive to the general happiness ; in the circumstances, rather venturesome. The following day began, also by Lady B.'s advice, to write on the Definition of Political Economy. Very much elated by "excellent news of the revolution in Italy." Attends three lectures on modern Greek, and gives his father an account of the departures from the ancient Greek. In the beginning of August the lessons are at an end, the family going for a tour in the Pyrenees. What remains of the diary is occupied with this tour, its incidents and descriptions, and is written in French.

I must, however, advert to an interesting letter from Lady Bentham to his father, dated September 14th. It refers to a previous letter of hers giving particulars of John's progress in French and other branches of acquirement. The family is to reside in Montpellier, and the purpose of the present letter is to recommend to his father to allow him to spend the winter there, and to attend the public lectures of the college. Mr. Bernard, a distinguished chemist, who had visited the Benthams at Toulouse, had taken an interest in him, and sounded his depths and deficiencies, and gives the same opinion. As the party has now been boxed up together for some weeks, his habits and peculiarities had been more closely attended to than ever, and (I quote the words) "we have been considerably successful in getting the better of his inactivity of mind and body when left to himself." This probably refers to his ennui when deprived of books ; it being apparent that, much as was his interest in scenery, he could not as yet subsist upon that alone. The letter goes on—"Upon all occasions his gentleness under reproof and thankfulness for correction are remarkable ; and, as it is by reason supported by examples we point out to him that we endeavor to convince him, not by command that we induce him to do so and so, we trust that you will have satisfaction from that part of his education we are giving him to fit him for commerce with the world at large." Lady Bentham does not omit to add that he must also dress well.

The remainder of the diary serves mainly to show his growing taste

for scenery and his powers of description. He depicts climate, productions, villages, the habits of the people, as well as the views that were encountered. The party make the ascent of Le Pic du Midi de Bigorre, and he is in raptures with the prospect. "Mais jamais je n'oublierai la vue du côte méridionale." In short, to describe its magnificence would need a volume!

We may now conceive with some degree of precision the intellectual caliber of this marvelous boy. In the first place we learn the number of hours that he could devote to study each day. From two to three hours before breakfast, about five hours between breakfast and dinner, and two or three in the evening, make up a working day of nine hours clear; and while at Toulouse scarcely any portion of his reading could be called recreative. His lightest literature was in French, and was intended as practice in the language. Probably at home his reading-day may have often been longer; it would scarcely ever be shorter. For a scholar in mature years eight or nine hours' reading would not be extraordinary; but then there is no longer the same tasking of the memory. Mill's power of application all through his early years was without doubt amazing; and, although he suffered from it in premature ill-health, it was a foretaste of what he could do throughout his whole life. It attested a combination of cerebral activity and constitutional vigor that is as rare as genius; his younger brothers succumbed under a far less severe discipline.

That the application was excessive, I for one will affirm without any hesitation. That his health suffered we have ample evidence, which I shall afterward produce. That his mental progress might have been as great with a smaller strain on his powers, I am strongly inclined to believe, although the proof is not so easy. We must look a little closer at the facts.

I can not help thinking that the rapid and unbroken transitions from one study to another must have been unfavorable to a due impression on the memory. He lost not a moment in passing from subject to subject in his reading: he hurried home from his music-lesson or fencing-lesson to his books. Now, we know well enough that the nervous currents, when strongly aroused in any direction, tend to persist for some time: in the case of learning anything, this persistence will count in stamping the impression; and part of the effect of a lesson must be lost in hurrying without a moment's break to something new, even although the change of subject was of the nature of relief. By his own account, his lessons at Toulouse, with the exception of French and music, took no effect upon him. Nor is this the worst feature of Mill's programme. According to our present notions of physical and mental training, he ought to have had a decided break in the afternoon. Considering that he was at work from about six in the morning, with only half an hour for breakfast, he should clearly have had, between one and two, a cessation of several hours, extending over dinner; especially as

he gave up the evening to his hardest subjects. Of course this interval should have been devoted to out-of-doors recreation. It is quite true that both father and son were alive to the necessity of walking, and practiced it even to excess; in fact, counted too much upon it as a means of renewing the forces of the brain: their walks were merely a part of their working-day—a hearing and giving of lessons.

What with his own recital in the "Autobiography" and the minuter details in the letter to Sir S. Bentham, and the diary, we have a complete account of his reading and study in every form. The amount is, of course, stupendous for a child. The choice and the sequence of books and subjects suggest various reflections. His beginning Greek at so early an age was no doubt due to his father's strong predilection for the language. What we wonder at most is the order of his reading. Before his eighth year, he had read not merely the easier writers, but six dialogues of Plato (the Theætetus he admits he did not understand). He was only eight when he first read Thucydides, as well as a number of plays. At nine he read parts of Demosthenes; at eleven he read Thucydides the second time. What his reading of Thucydides could be at eight, we may dimly imagine: it could be nothing but an exercise in the Greek language; and the same remark must be applicable to the great mass of his early reading both in Greek and Latin. At Toulouse we find him still reading Virgil, of although five years before he had read the Bucolics and six books the Æneid. Moreover, at Toulouse, his Greek reading was Lucian, a very easy writer whom he had begun before he was eight; the noticeable fact being that he is now taking an interest in the writer's thoughts and able to criticise him. It is apparent enough that his vast early reading was too rapid, and as a consequence superficial. It is noticeable how rare is his avowal of interest in the subjects of the classical books; Lucian is an exception; Quintilian is another. He was set by his father to make an analysis of Aristotle's Rhetoric and Organon, and doubtless his mind was cast for Logic from the first. His inaptitude for the matter of the Greek and Latin poets is unambiguously shown; he read Homer in Greek, but his interest was awakened only by Pope's translation. His readings in the English poets for the most part made no impression upon him whatever. He had a boyish delight in action, battles, heroism, and energy; and, seeing that whatever he felt, he felt intensely, his devotion to that kind of literature was very ardent. But whether from early habits, or from native peculiarity, he had all his life an extraordinary power of *re*reading books. His first reading merely skimmed the subject; if a book pleased him, and he wished to study it, he read it two or three times, not after an interval, but immediately. I can not but think that in this practice there is a waste of power.

It was impossible for his father to test the adequacy of his study of Greek and Latin works, except in select cases; and hence it must have

been very slovenly. In Mathematics, he had little or no assistance, but in it there are self-acting tests. His readings in Physical Science were also untutored: unless at Montpellier, he never had any masters, and hisknowledge never came to maturity.

If I were to compare him in his fifteenth year with the most intellectual youth that I have ever known, or heard or read about, I would say that his attainments on the whole are not unparalleled, although, I admit, very rare. His classical knowledge, such as it was, could easily be forced upon a clever youth at that age. The Mathematics could not be so easily commanded. The best mathematicians have seldom been capable of beginning Euclid at eight or nine,[1] and even granting that in this, as in other subjects, he made small way at first, yet the Toulouse diary shows us what he could do at fourteen; and I should be curious to know whether Herschel, De Morgan, or Airy could have done as much. I have little doubt that, with forcing, these men would all have equaled him in his Classics and Mathematics combined. The one thing, in my judgment, where Mill was most markedly in advance of his years, was Logic. It was not merely that he had read treatises on the Formal Logic, as well as Hobbes's "Computatio sive Logica," but that he was able to chop Logic with his father in regard to the foundations and demonstrations of Geometry. I have never known a similar case of precocity. We must remember, however, that while his father pretended to teach him everything, yet, in point of fact, there were a few things that he could and did teach effectually: one of these was Logic; the others were Political Economy, Historical Philosophy and Politics, all which were eminently his own subjects. On these John was a truly precocious youth; his innate aptitudes, which must have been great, received the utmost stimulation that it was possible to apply. His father put enormous stress upon Logic, even in the scholastic garb; but he was himself far more of a logician than the writers of any of the manuals. In that war against vague, ambiguous, flimsy, unanalyzed words and phrases, carried on alike by Bentham and by himself, in the wide domains of Politics and Ethics, he put forth a faculty not imparted by the scholastic Logic; and in this higher training the son was early and persistently indoctrinated. To this were added other parts of logical discipline which may also be called unwritten: as for example, the weighing and balancing of arguments *pro* and *con* in every question; the looking out for snares and fallacies of a much wider compass than those set down in the common manuals. (See the beginning of the "Bentham" article for Mill's delineation of Bentham's "Logic.")

He returned to England in July, 1821, after a stay of fourteen months. He sufficiently describes the fruits of his stay in France, which included a familiar knowledge of the French language, and acquaintance with

[1] Locke knew a young gentleman who could demonstrate several propositions in Euclid *before he was thirteen.*

ordinary French literature. If we may judge from what he says afterward, his acquaintance with the literature was strictly *ordinary;* he knew nothing of the French Revolution, and it was at a much later period that he studied French authors for the improvement of his style.

He had still nearly two years before entering on official life; and he tells us how these were occupied. His father had become acquainted with John Austin, who assisted him in Roman Law, his destination being the bar. He also got deep into Bentham for the first time, and began Psychology. He now read the history of the French Revolution. An undated letter to his father probably belongs to this period. He was on a visit to Mr. and Mrs. Austin at Norwich. The letter begins with a short account of his studies. He read Blackstone (with Mr. Austin) three or four hours daily and a portion of Bentham's "Introduction" (I suppose the Morals and Legislation) in the evening. Among other things, "I have found time to write the defense of Pericles in answer to the accusation which you have with you. I have also found some time to practice the delivery of the accusation, according to your directions." Then follows an account of a visit of ten days with the Austins to the town of Yarmouth, with a description of the place itself. The larger part of the letter is on the politics of Norwich, where "the Cause" (Liberal) prospers ill, being still worse at Yarmouth. He has seen of Radicals many; of clear-headed men not one. The best is Sir Thomas Beever, whom he wishes to be induced to come to London and see his father and Mr. Grote. At Falmouth he had dined with Radical Palmer, who had opened the borough to the Whigs; not much better than a mere Radical. "I have been much entertained by a sermon of Mr. Madge, admirable as against Calvinists and Catholics, but the weakness of which as against anybody else I think he himself must have felt." The concluding paragraph of the letter should have been a postscript:

> I wish I had nothing else to tell you, but I must inform you that I have lost my watch. It was lost while I was out of doors, but it is impossible that it should have been stolen from my pocket. It must therefore be my own fault. The loss itself (though I am conscious that I must remain without a watch till I can buy one for myself) is to me not great—much less so than my carelessness deserves. It must however vex you—and deservedly, from the bad sign which it affords of me.

On his return from France, he resumed energetically the task of home teaching; making a great improvement in the lot of his pupils, who were exclusively under their father's care in the interval; for while he scolded them freely for their stupidity and backwardness, he took pains to explain their lessons, which their father never did. He was kept at this work ever after. I remember on one occasion hearing from Mrs. Grote that she had turned up an old letter from James Mill, in answer to an invitation to John to accompany Mr. Grote and her on a

vacation tour; the reply was that he could not be spared from the work of teaching the younger children.

The "Autobiography" gives a full account of his acquaintances among the young men resident at Cambridge, who afterward came to London, including, besides Charles Austin, who was the means of introducing him, Macaulay, Hyde and Charles Villiers, Strutt (Lord Belper), Romilly, etc. There is no mention of his having gone to Cambridge in 1822, on a visit to Charles Austin. The contrast of his boyish figure, and thin voice, with his immense conversational power, left a deep impression on the undergraduates of the time, notwithstanding their being familiar with Macaulay and Austin.

I alluded, in my last article on James Mill, to the persistent attempts of Professor Townshend, of Cambridge, to get John entered there. Here are two sentences from a letter dated March 29, 1823, two months before he entered the India House: "I again entreat you to permit me to write to the tutor at Trinity to enter your son's name at that noble college. Whatever you may wish his eventual destiny to be, his prosperity in life can not be retarded, but must on the contrary be increased by making an acquaintance at an English University with his Patrician contemporaries." Whether it would have been possible to induce his father to send him to Cambridge, I very much doubt. I suspect that, of the two, the son would have been the more intractable on the matter of subscription to the Articles. Ten years later, it was an open question in the house whether his brother Henry should be sent to Cambridge.

THE INTRA-MERCURIAL PLANETS.[1]

By CAMILLE FLAMMARION.

A GOOD deal of noise was made a few months ago about a discovery that an American astronomer believed he had made during the recent solar eclipse of July 29, 1878. At the moment of totality, while the bright disk of the sun was completely hidden by the black disk of the moon, and after the eye had become habituated to this sudden darkness, the American astronomer made a search to find whether there might not be, in the vicinity of the sun, a planet answering to the theoretical planet Vulcan, whose existence was announced by Leverrier after he had mathematically analyzed the motion of Mercury. As every one knows, during total eclipses of the sun, our atmosphere being no longer illumined, night comes on as though at the bidding of an enchanter, and the brighter stars make their appearance in the heavens. It is this sudden metamorphosis of nature that most forcibly impresses

[1] Translated from "La Nature" by J. Fitzgerald, A. M.

primitive races; it was this which, on the occasion of the earliest eclipse recorded in history—the eclipse of Thales—put a stop to the famous war of the Medes and the Persians, by sending the chill of mortal terror into the hearts of the warriors as they were on the point of engaging in battle; this it was which, at the last eclipse, led a negro, suddenly frenzied and convinced that a deluge was about to be sent down by an angered Deity, to strangle his own wife and children; finally, it is this same feature of the solar eclipse which makes the deepest impression on the mind of the astronomer who has made all his preparations for observation, but is so full of emotion in view of the grandeur of the spectacle, that he can only with difficulty analyze with his wonted coolness, and during the few minutes of total darkness, the details of the phenomenon.

The American astronomer Professor Watson, the discoverer of a great number of small planets, has declared that his one thought during the recent eclipse was to look for the intra-Mercurial planet. In announcing this observation to the Academy of Sciences, the Director of the Paris Observatory, M. Mouchez, expressed himself thus:

The accomplished astronomer of Ann Arbor has seen a heavenly body of the fourth magnitude, situated two degrees distant from the sun, and whose position was: right ascension, $8^h\ 26^m$; declination north, 18° 0′.

The star nearest to this position is Theta Cancri ($8^h\ 24^m$ and 18° 30′), and it is of the fifth magnitude. This difference of magnitude and of position justifies us in supposing that in all probability it was the planet Vulcan which was again seen by Mr. Watson. The Academy can not but receive with great pleasure this observation, which is only a new tribute to the scientific glory of Leverrier. M. Gaillot has calculated an orbit and an ephemeris. The time of revolution is only twenty-four days. The planet is at its greatest distance from the sun today (August 5th); to-morrow it will be at thirty-eight minutes of time. This distance is great enough to allow of our observing it, if not at Paris, at least at other more favored localities.

Watson's own account of the observation is as follows:

At the recent total eclipse of the sun I was occupied exclusively in a search for any intra-Mercurial planet which might be visible. For this purpose I employed an excellent four-inch refractor, by Alvan Clark & Sons, mounted equatorially with a magnifying power of forty-five. There were no circles originally attached to the instrument, and accordingly I placed on it circles of hard wood, the declination circle being five inches and the hour circle four and three quarter inches in diameter. On these I pasted circles of cardboard, and pointers were provided so that I could mark with a sharp pencil the position corresponding to any particular pointing of the instrument. This method does not compare in accuracy with graduated circles and veniers, but it has the advantage, and a very important one in the present case, of avoiding the uncertainty which might be attributed to erroneous readings of the circles. To read the divided circles would require considerable time, while the pointings can be marked on the paper disks in a few moments. And, besides, while a doubt might be raised as to the correctness of the recorded circle readings, no such doubt can exist in reference to the positions marked on these paper circles. The chronometer

times corresponding to each pointing were recorded, and the designation of the object observed was also marked on the paper disks, so that there is no difficulty in identifying the several marks.

He then goes on to give the particulars of his sweeps over the regions east and west of the sun, which were without result till, at last—

Between the sun and θ Cancri . . . I came across a star estimated at the time to be of four and a half magnitude, which shone with a ruddy light and certainly had a larger disk than the spurious disk of a star. The focus of the eye-piece had been carefully adjusted beforehand and securely clamped, and the definition was excellent. I proceeded, therefore, to mark its position on the paper circles, and to record the time of observation. It was designated by *a*. The place of the sun had been recorded a few minutes previously, and marked S_1. Placing my eye again at the telescope, I assured myself that it had not been disturbed, and proceeded with the search. I noticed particularly that the object in question did not present any elongation such as would be probable were it a comet in that position.

This body he holds to be Leverrier's intra-Mercurial planet. Its place is given as follows: $8^h\ 26^m\ 24^s$; declination 18° 16′. It will be seen that this position differs from that given above, the declination being here 18° 16′, instead of 18° 0′.

On August 23d the observer added a new correction: "In consequence of having employed an inexact value for the correction of the chronometer, an error has crept into the results. The true position is this: right ascension, $8^h\ 27^m\ 35^s$; declination, 18° 16′."

Here we have a fresh difference in the first figure. The result is, first, that the orbit calculated immediately upon receipt of the telegram was made too hastily and on an insufficient basis.

According to the American observer, the definitive differences between the planet and the sun were: in right ascension, $8^m\ 21^s$; in declination, 0° 22′. But in this same letter of August 23d he announces that he observed another star, also of the fourth magnitude, which presented the following differences from the sun: in right ascension, $27^m\ 18^s$; in declination, 0° 35′. Whence results for this second star the position: right ascension, $8^h\ 8^m\ 38^s$; declination, 18° 3′.

A fourth datum sent to the London Royal Astronomical Society again corrects these positions as follows:

$$8^h\ 27^m\ 24^s + 18°\ 16′$$
$$8^h\ 9^m\ 24^s + 18°\ 3′$$

We will remind our readers that the right ascension of a star is its distance east or west from the first point of Aries, measured along the celestial equator, and its declination is its distance above or below that equator. They are the longitudes and latitudes of the heavens, corresponding to those of earth, and they serve to determine the positions of stars as earth longitudes and latitudes serve to fix in geography the exact positions of cities.

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And now comes another American astronomer, Mr. Swift, who also announces that during the same total eclipse he observed simultaneously in the field of his telescope two stars, of which the one was Theta Cancri, and the other a planet shining with the luster of a star of the fifth magnitude, and whose position he estimates approximately to be, right ascension $8^h\ 26^m\ 40^s$, declination $+18°\ 30'\ 35''$, a position very near to that of the star seen and determined by Mr. Watson.

The eclipse of July 29th last, one of the most remarkable of the present century for the duration of totality, was observed all along the zone of centrality (which passed across North America), by a great number of able astronomers, both American and English. Nearly all of these searched for a new star in the neighborhood of the sun, but, with the exception of the two named above, all declare that they saw nothing beyond the stars rendered momentarily visible by the obscuration of the sun's light.

Are we thence to conclude that the testimony of these two observers must be rejected? By no means. But between this and the conclusion that the two stars signalized by Watson are in fact two planets traveling between Mercury and the sun, is a long way. Of these two stars, the second, it is supposed, can not be the star Zeta Cancri, whose position is $8^h\ 5^m\ 12^s$ and $18°\ 2'$.

The difference of three minutes is no doubt very great, but when we take account of the haste of observation, and the doubt expressed by the observer himself with regard to its exactness and the possible derangement of his telescope by the action of the wind, this star must not be dismissed without seeing whether or not it will explain the observations. Now, supposing an error of three minutes more or less, the position of the first star becomes $8^h\ 24^m$ and $18°\ 16'$, and this is very nearly the position of the star Theta Cancri.

All that is needed to show how probable is this explanation is to take up a celestial atlas and to locate the sun at the point where it was at the moment of the eclipse, i. e., in front of Delta Cancri (which was visible through the aureolar corona of the eclipsed sun, at its eastern margin).

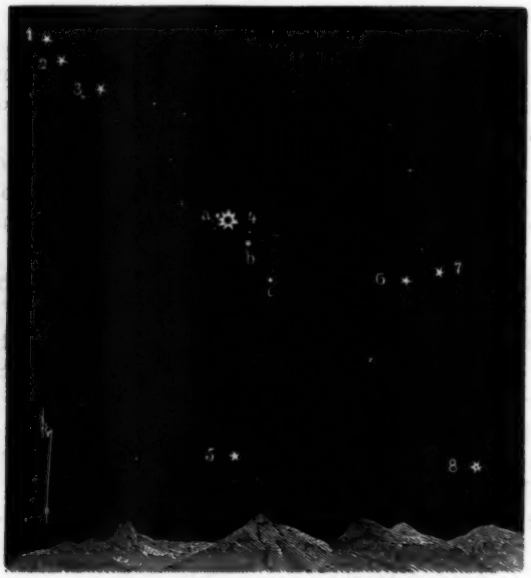
We have reproduced in the figure the aspect of the heavens during totality.

1 is Mercury,
2 is Regulus,
3 is Mars,
4 is the sun in eclipse,
5 is Procyon,
6 is Pollux,
7 is Castor,
8 is Venus.

In the immediate vicinity of the sun we have inserted at the points *a*, *b*, *c*, the three stars Delta, Theta, and Zeta Cancri. In our opinion the two stars *b* and *c* are the ones which might have been taken for two planets by the American observers. No doubt this hypothesis is a rather bold one, but then the hastiness, the difficulty, and the vagueness of the observation justify it.

Mr. Watson did not announce his observation of the second star till three weeks after the eclipse, and after he had revised in detail the conditions of his observation. Here is proof that this star had made a less impression on him than the first. But now the first is between the fourth and fifth magnitudes, and the second only between the fifth and the sixth.

In any case, we can not but hold that the positions given are highly doubtful and can not be seriously assumed as a basis for calculating orbits, as has been done at the observatory.



Mr. Swift writes, "I have no doubt that one of the two stars was Theta Cancri, and the other the intra-Mercurial planet."

But if one of the two stars seen by Professor Watson is Theta Cancri, the other, whose difference from the former is, according to him, $18^m\ 57^s$ more to the west, and $13'$ more to the south, comes exceedingly near to Zeta Cancri, whose difference from Theta is $19^m\ 25^s$ also to the west, and $30'$ also to the south. If this star were a planet it would not have been possible to see it without at the same time seeing Zeta, which would have been quite near; but of Zeta our American astronomers do not speak.

Mr. Swift, however, answers this objection by saying that he saw simultaneously Theta and the planet, and states the difference between them as follows:

	Right ascension.	Declination.
Star Theta,	$8^h\ 24^m\ 40^s$	$+ 18°\ 30'\ 20''$
Planet,	$8^h\ 26^m\ 40^s$	$+ 18°\ 30'\ 25''$

The two stars appeared red to him, shining at three degrees southwest of the sun, and presenting large disks of the fifth magnitude. He adds that he saw no other star, not even Delta, and that the distance between them was from 7′ to 8′ of arc. ("Nature," September 19, 1878.)

The two stars seen by Swift, then, are not the same two seen by Watson. The matter is a good deal confused.

Further, in observing the star Zeta Cancri, two stars could have been seen, instead of one, for Zeta is a double star. It is, indeed, a triple star, but a high power is required to see it triple, whereas a moderate power easily shows it double. But, inasmuch as only very low powers were employed, it is probable that no new cause of perplexity exists here.

To sum up: While it is possible that the American observers saw an intra-Mercurial planet, or even two, we can not, in view of the special difficulties of the situation, the confusion of the figures, and the negative observations of the other observers, concede it to be an absolute and incontestable fact that they saw even so much as one. The fact is not yet *certain*.

We would remark that no variable star is known to exist at that part of the heaven. Might it not be a comet? It did not present the characteristics of a comet.

Whatever the upshot may be, this discussion goes to show that in astronomy nothing is accepted without being first verified, and that this science is becoming more and more worthy of its reputation of being the exactest and the most absolute form of human knowledge.

This strange vicinage of the sun is unfortunate indeed in the annals of astronomy. Time and again have observers supposed that they saw planets passing before the sun; and, out of all the observations which have been made, there is not one which definitively settles the question.

The penultimate astronomical observation announced as appertaining to an intra-Mercurial planet was that of the German astronomer Weber, which was presented to Leverrier by Wolf, of Zurich, as having been made April 4, 1876, at Peckeloh. "A small, well-rounded disk of 12″ of arc appeared suddenly during a partial clearness of the sky (*éclaircie*), which was turned to account for observing the sun. It was impossible to pursue the observation, owing to clouds." Wolf calculated that this observation accorded with two prior observations made in 1859 and in 1820, and fixed the period of the planet at forty-two days. Leverrier, too, seemed disposed to accept this observation, which gave occasion for a new memoir by the illustrious French astronomer, in which he brought together and compared all the observations of this kind. The stir which this made in the scientific periodicals is still remembered. But yet the little black disk observed by Weber was not a planet at all, but merely a sun-spot, round and without penumbra. It had been observed five hours earlier at the Observatory of Madrid and at the Observatory

of Greenwich, and it was easy to prove that it was nothing but a simple sun-spot.

The fact that the spot was not to be seen the next day seemed to confirm the planetary hypothesis; but it was not sufficient, since there are ephemeral sun-spots, too. Nor is the roundness of the spot a distinctive character either. The proper movement then remains. Here we must note a circumstance which oftentimes must have caused illusions. When we observe the sun with a telescope not equatorially mounted, and whose support has not the two motions, vertical and azimuthal, as is commonly the case, the position of a sun-spot, by reason of the diurnal motion, is ever changing with relation to the vertical diameter of the disk. Even when an observer has had large experience, it is difficult for him to guard against the belief that the spot has changed its position on the disk.

This observation, then, had to be disallowed. But there remained others which were not to be discredited on the same grounds, and Leverrier, taking them to be more trustworthy, used them in calculating the orbit of the hypothetical planet. Different interpretations gave him five different orbits, with periods varying between twenty-four and fifty-one days. But he seems to have preferred that which gives a period of thirty-three days, and announced that on March 22, 1877, the planet in question might pass before the sun. Astronomers all over the world, with one accord, observed the sun on that day, to descry the transit, but the result was *nil*. No black point was to be seen.

Among the prior observations Leverrier accepts five as certain, viz.: Fritsche's, in 1802; Stark's, in 1819; Cuppis's, in 1839; Sidebotham's, in 1849; Lescarbault's, in 1859; Lumnis's, in 1862. One of the best is no doubt that of Dr. Lescarbault, a country doctor, with a passion for astronomy, and who had vowed to the study of the heavens the time which was not spent in alleviating the wretchedness of earth.

This amateur astronomer, while observing the sun on March 26, 1859, from his humble house at Orgères, discovered on its radiant disk a round, very black spot, which he was able to study for over an hour, and the proper motion of which he thus determined, no doubt taking account of the causes of error to which we have alluded. It was during this same year that Leverrier perceived the necessity of increasing by 38″ the secular movement of Mercury's perihelion, and offered the hypothesis that a planet nearer to the sun than Mercury would account for the difference. Thus the observation made by my old and learned friend came as though on purpose to confirm the theory, just as earlier the telescopic discovery of Neptune had come to confirm so brilliantly the theoretical discovery of that distant planet.

Wellnigh twenty years have passed since 1859, and yet a fact which one might have supposed would be speedily confirmed, owing to the rapidity of the planet's revolution, and its no doubt frequent transits across the sun—this fact has received no confirmation. Yet search

has been made for it throughout the whole region on both sides of the sun, if perchance it might be seen at the periods of its greatest distance. Perhaps not a day has passed for the last twenty years, but that the sun has been examined at one point or another of the globe, observed with the greatest care, sketched in all its details, even directly photographed.

The hypothesis of a single body comparable to Mercury, gravitating in close proximity to the sun, and on a plane probably little inclined to the solar equator, seems to us to be so open to objections as to be untenable. Still, the mathematical theory of universal attraction proves that there is a cause for the retardation observed in the motion of Mercury, and that this cause can not be found by augmenting the mass of Venus —a quantity now determined with great exactitude—but must be sought for in some disturbing mass between Mercury and the sun. But this mass may not be a planet worthy of the name of planet; it may consist of a great number of asteroids like the minute fragments which gravitate between Mars and Jupiter—asteroids so small that oftentimes they escape the notice of observers of the sun and of eclipses, though some of them may be large enough to be seen under certain rare conditions. This latter theory is the one which we adopt.

DIETETIC CURIOSITIES.

By FELIX L. OSWALD, Ph. D., M. D.

I.

"MAN is what he eats" (Der Mensch ist was er *isst*) is a German proverb, the propriety of which may be chiefly alliterative, though the apothegm of our greatest English physician goes even further: "If we could solve the problem of diet," Dr. Radcliffe tells us, "it would almost amount to the rediscovery of paradise. Wrong eating and drinking, and the breathing of vitiated air (which is gaseous food), these form the triple fountain-head of nearly all our diseases and our misery."

Even a great doctor is fallible, especially on his hobby, but it is not easy to deny the importance of a subject which can assert itself by such dire *argumenta ad hominem* as dyspepsia, congestive chills, and other penalties that follow swifter now than in old times on any violation of the physical laws of God. Love of health or fear of sickness (which differ as ancient from modern civilization) has always made the question of diet one of primary interest; yet there is certainly none about which doctors disagree more widely. It is amusing to compare the different food-theories which have been cherished like plans of salvation

since the fighting of un-nature first became a science. If contradictory tenets imply error, we surely are further from unitary truth here than anywhere except in the Babel of speculative theology; and even there only dogmatic assertion, but not inconsistency, could ever go further. Just compare the gospel of Pythagoras with that of Dr. Brown, the Berwick prophet. Abstinence from wine—alcoholic stimulants, we would say at present—and from all animal food is the keystone of the Pythagorean system, which also denounced the shedding of blood, and recommended the use of "food which needs no cooking"—fruit, nuts, honey, milk, and the like. But John H. Brown, M. D., divides all possible states of health into the "sthenic and asthenic conditions," the first to be toned down by bleeding, cathartics, etc., the second to be rallied by a liberal use of brandy and strong meats, which in more moderate quantities are to constitute our normal food, while all raw vegetable products are to be avoided, especially "acid and subacid fruit."

Is there a greater antagonism in all the *toto-cœlo* distance from Odin to Mother Ann Lee? If either was right, the other must have been portentously wrong; yet the school of Berwick, not less than that of Samos, counted its disciples by tens of thousands. Again, is there an hygienic tenet which seems more incontrovertible to us than the propriety of the three daily meals? Yet the Romans of the ante-Cæsarean era, who as physical beings were so strangely superior to us, restricted themselves to a single meal in the twenty-four hours, for which they chose the very time when we dread repletion most—the end of the day, the hour between sunset and darkness.

Moses transmits from the lips of Jehovah his by-laws against pork and rabbit-flesh, and we know how many of his followers preferred death to the obnoxious diet, but our Saxon forefathers exalted the pigs' feet of Valhalla as the supreme reward of heroic virtue, and, dying, the Baresark could grin through his tortures at the thought of celestial spareribs. Charlemagne, when informed that his life depended on a change of *régime*, declared that if he could purchase immortality by absenting himself from the customary tri-weekly barbecues, he would think the price too high. He may have doubted the efficacy of the sacrifice, but the Mingrelian ambassadors, after receiving Abu-Hassan's stern ultimatum, "Islam or the sword!" informed him that, however willing they might be to propitiate the wrath of Allah, the national assembly preferred war and pork to peace without it.

Thales considered water as the *summum bonum*, and many of his teachings seem to anticipate the hydropathic school and our temperance dogmas; but Paracelsus proclaimed to the world that he had found the true panacea and the elixir of life by the discovery of alcohol, and seems to have been only too successful in his propaganda. "He finds believers who himself believes"; and Paracelsus certainly proved personal confidence in his doctrine by swallowing (in the city of Salzburg, 1541), as the "grand quintessence of life," a five-pint bottle of alcohol,

which it had taken him two months to distill. The funeral was very impressive, as the Salzburg chronicle thinks it necessary to observe. We know that our North American Indians are purely carnivorous, and persistently neglect all opportunities of enlarging their *menu;* also, that white men who voluntarily or otherwise shared their fortune and potluck for a few years, refused to rejoin Caucasia afterward. Similar stories were told in ancient Greece of the Lotophagi (lotus-eaters), a people of peculiar habits, who boasted that any stranger living among them for a little while would rather resign kinsmen and country than leave them again, only with this difference: the magnetism and the name of the Lotophagi were derived from their diet of lotus-leaves—they were strict vegetarians.

With every allowance for a possible diversity of constitutions, generic differences, and the modifying influence of climate, the subject still presents enigmas which almost force upon us the conclusion so fiercely rejected by Jean Jacques Rousseau, that nature and habit are interchangeable terms. Two hundred million Hindoos abstain from the use of animal food, by behest of Vishnu, as they say; by necessity of climate, as we explain it. But the inhabitants of Southern Africa, in defiance of Vishnu and climate, gorge themselves with meat as often as they can procure it, and with perfect impunity, it seems.

"Meat," says Professor von Liebig, "is preëminently the muscle-forming food; hence the difference between the stout Briton and the lean Spaniard, the delicate Hindoo and the robust Ethiopian." But the Lesghian mountaineers and the box-carriers of Constantinople, though not vegetarians by principle, subsist chiefly on fruit and farinaceous food, and it so happens that every other man of them can shoulder a load that would task the combined strength of the stout Briton and robust Ethiopian. The powerful arms and the ponderous, leonine bearing of the occasional Turks who visit the fairs of Vienna and Buda-Pesth are a fine practical argument in favor of temperate habits; yet their rivals in strength, the iron-fisted Bauern of Upper Austria and the Bavarian highlands, are notorious for their abject worship of beer.

But, for all that, it would be wrong to abandon the hope of rediscovering paradise by Dr. Radcliffe's road. Whatever may be the right way, we can not afford to swerve from it, least of all consciously, and that we are astray at present is most distressingly probable. Dr. Boerhaave reminds us that there are certain maxims of health, so clearly pointed out by *a priori reasoning*, that we can not be too cautious in the acceptance of contradictory evidence.

"For instance, the exceptional cases of robust health in conjunction with habits denounced as injurious by all analogy ought to make us inquire how this impunity is earned; which strong protector of health could overcome such an enemy. For there is such a thing as *vicarious atonement* in physiology. Athletic sports, fatiguing rides on horseback, and any long-continued exercise in open air, seem to grant a long im-

munity from the effects of vicious diet; and it seems that there is a peptic stimulus in mountain air and the climate of a high latitude."

The kitchen-reformers of England and North America seem united on the question of alcohol only, but contradict each other and sometimes themselves in their food-theories and general toxicology. The hygienic system of Dio Lewis embraces the vegetarian, total abstinence, and hydropathic dogmas, but in consistent logic and ingenuity is far surpassed by that of Schrodt, the Swiss dietist.

In his "Natur-Heilkunde," Schrodt distinguishes between natural, artificially adapted, and unnatural or wholly injurious articles of food. "Our natural food," he says (like Pythagoras), "are such vegetable and semi-animal products *as either are or can be eaten and relished raw, and without the preliminaries of cooking and spicing.* Such are milk, honey, eggs, nuts, cereals, a few roots, legumina, and gums, and the countless variety of fruit, which are man-food *par excellence.* Our various kinds of bread, though artificially prepared, as well as other farinaceous dishes, are derived from an edible grain which is neither repulsive nor indigestible in its original state.

"To the second or adapted edibles belong different vegetables which are rendered palatable only by the process of cooking, as cabbage, beans, peas and lentils, and various roots and leaves. Flesh, also, I will add to this list, though some would place it in the third class. Injurious, without a redeeming quality, are all narcotic and alcoholic drinks, and all ardent spices, such as pepper, mustard, and acid fluids; also those partly decayed and acid substances whose properties are more stimulating than nourishing: strong cheese, sauerkraut, and pickles."

This system is based on the idea that an unvitiated taste is a sufficient criterion of healthfulness in food, and that to the palate of a child all wholesome substances are agreeable, all injurious ones repulsive. "A taste for the so-called articles of diet embraced in my third class," says Herr Schrodt, "is always *artificially and painfully acquired.* No man of veracity or memory will tell me that he liked cheese or brandy at first." In accounting for the prevalence of stimulation and intemperance among seemingly healthy nations, he too falls back on vicarious atonement by otherwise salutary habits.

Viewed in the light of Dr. Boerhaave's theory, the gastronomic exploits of ancient and modern savages may gain an additional interest. How desirable it would be to know by which vicarious virtue his Majesty the Emperor Vitellius could atone for the often-repeated sin of devouring three brace of peacocks at a sitting, which Suetonius assures us did not prevent him from appearing in the palestra an hour afterward and joining in the games which were prolonged by torchlight toward the morning hour! Vendôme, the champion of France and the one strategic peer ever opposed to Marlborough, was as formidable at the mess-table as on the battle-field. He would gorge himself till his joints

commenced to tremble and the oppression of his chest threatened him with asphyxia. Woe to the waiter or messmate who offended him by word or want of attention in such moments! A fierce blow, a hurled tumbler, or a tremendous kick were the mildest expressions of his impatience. After the defeat of Oudenarde he saved the French army by a masterly retreat that kept him in the saddle for two days and two nights, and then restored himself, not by sleep, but by sitting down to a banquet of sixteen hours, during which he incorporated as many pounds of mutton-pie, if we may believe Chateaubriand.

Calmucks, according to Mr. Schuyler, will travel a hundred miles to stuff themselves with horseflesh at somebody else's expense; and Gordon Cumming mentions a family of Zulu-Caffres—a man, two wives, and four children—who, between noon and sunset, disposed of all the meat, marrow, and intestines of a large zebra, and during the following night picked the bones in a way which only an army of ants could emulate. Vambéry speaks of a Tartar courier, named Thuy-Kasr, who boasted of having eaten, "unassisted and without employment of witchcraft," a large skinful of raisins and a middle-sized pig, leaving nothing but bristles and a few of the larger bones; and once, within fifty hours, even a goat with two kids, together with a bag of dried figs and deep potions of *koumiss* or fermented mare's milk. Thuy-Kasr must have known the secret of Apicius, "which enabled the adept to prolong his appetite for two days and a night." But such Tartars are not the exclusive product of Central Asia. James Halpin, a Yorkshire man, who exhibited himself in Manchester and other English cities during the first years of this century, thought nothing of eating a dozen pigeons, bones, feathers and all; swallowed trout and larger fishes alive, and won a wager by devouring within two hours all the edibles, including half a cheese and a large quantity of pickles, on a table that had been set for eight persons!

Joseph Kolnicker, born 1809 in Passau, southern Germany, who served as a private soldier for a couple of years, had to be discharged before the expiration of his term on account of his appalling appetite. He would devour raw potatoes, horse-turnips, cabbages in the garden, could empty basketfuls of eggs in a few minutes, and, in spite of all precautions, gained admittance to an officer's pantry or the commissary storerooms now and then, and with most deplorable results. He, too, converted his expensive talent into a source of profit by public exhibitions, and won so many incredible bets that, much to his regret, his renown eventually spread like that of the athlete Milo, and nobody dared to challenge him.

But no modern virtuoso can emulate the giants of antiquity. Claudius, Caligula, Domitian, and Heliogabalus, the imperial gluttons, almost exhausted the resources of the Orbis Romanus by their monstrous voracity. Cicero compares the scene after a Roman banquet to a battlefield; and many of the wealthiest patricians were ruined by one or two

of those entertainments, to which the above-named potentates had an unpleasant habit of inviting themselves.

The symposia of Apicius lasted from twenty to thirty hours, and his semi-annual state dinners even two days, during which host and guests were restricted to recesses of ten minutes, and etiquette required them to partake of every dish and drink, the quantity being optional, except in regard to certain spiced wines, of which a good-sized jug was *de rigueur*—a rule which could only be circumvented by liberal libations to the gods. Yet even excess itself was exceeded by the mania of Vitellius, who wasted the yearly revenue of a province on a single banquet, gorged himself for hour after hour without intermission, and, in the words of Tacitus, "unadmonished by the eruptive protests of nature, never thought of yielding while he could see and hear"! He and some of his successors on the throne of gluttony probably owed their immunity to the virtues of a long lineage of frugal ancestors. Italy, truly, is the land of contrasts, of extremes in virtue as well as in vice. The resources wasted on a single day at one of those saturnalia of intemperance would probably have fed a village for a century of the early republican era, and for at least twenty years in our present time of poverty-born frugality. Frugal, in its original sense, meant literally subsisting on fruit in distinction to carnivorous habits, which were thought extravagant. Cyrus, King of Persia, according to Xenophon, was brought up on a diet of water, bread, and cresses, till up to his fifteenth year, when honey and raisins were added; and the family names of the Fabii and Lentuli were derived from their customary and possibly exclusive diet. Eggs and apples, with a little bread, were for centuries the alpha and omega of a Roman dinner; and, in earlier times, even bread and turnips, if not turnips alone, which the patriot Cincinnatus thought sufficient for his wants. It is singular that our temperance societies direct their efforts only against the fluid part of our vicious diet; a league of temperate eaters would certainly find a large field for reform. But in Italy the thing was attempted by Luigi de Cornaro, a Venetian nobleman of the fifteenth century, who restricted himself to a daily allowance of ten ounces of solid food and six ounces of wine, and prolonged his life to one hundred and two years. Though he did not organize his followers into a sect, his example and his voluminous writings influenced the manners of his country for many years. Cornaro would not have gained many converts in Russia and Germany; but throughout southern Europe frugality, in the truest old Latin sense, is by no means rare. Lacour, a Marseilles 'longshoreman, earned from ten to twenty francs a day, loaned money on interest and gave alms, but slept at night in his basket, and subsisted on fourteen onions a day, which preserved him in excellent health and humor, but got him the nickname of *quatorze oignons*.

A pound of bread with six ounces of poor cheese, and such berries as the roadside may offer, constitute the daily ration of the Turkish

soldier on the march, and the followers of Don Carlos contented themselves with even less. A correspondent of the "Daily News" was served with a dish of radishes in a Catalan tavern, and ventured the remark that radishes were taken after meals in northern Europe. "You can get some more after finishing these," was the reply. The radishes constituted the dinner.

Not that men *should*, but that they *can*, live on bread alone, is abundantly proved by the records of Old-World prisons. Silvio Pellico, the Italian patriot and martyr, subsisted for seven years on coarse rye-bread and water, which experience had taught him to prefer to the putrid pork-soup of his Austrian bastile. The prisoners of the Khedive were fed on rice and Indian corn, till the prayers of the French residents and his American officers induced him to sweeten their bitter lot by a weekly bottle of sakarra, or diluted molasses; and I learn from an article in a French journal that some of these unfortunates, who had passed long years without any hint of sakarra, were forced by chronic bowel complaints to return to their old dry fare.

Fedor Darapski, born 1774 in Karskod near Praga, eastern Poland, was brought to the government of Novgorod in his twenty-second year as a conscript to the Russian army, and was soon after sentenced to death for mutiny and assault with intent to kill. The Empress Catharine, acting on a recommendation of the Governor of Novgorod, commuted his sentence to imprisonment for life, but ordered that on every anniversary of the deed (an attempt to kill his colonel) the convict should receive forty lashes and be kept on half rations for a week after; the full ration being two pounds of black bread and a jug of cold water. On these terms Darapski was boarded at the fortress of Kirilov till 1863, when at the approach of his ninetieth birthday he was again recommended to mercy and liberated by order of the present Czar.

Even the story of Nebuchadnezzar may be more than an allegory, as the wild berries, roots, and grass-seeds of the Assyrian valleys contained surely as much nourishment as sour rye-bread; and who knows but grass itself might do for a while, since the Slavonian peasants often subsist for weeks at a time on sauerkraut and cabbage-soup?

Corsican farmers live all winter on dried fruit and *polenta* (chestnut-meal); and the Moors of mediæval Spain used to provision their fortified cities with chestnuts and olive-oil. During the siege of Lucknow the native soldiers asked that the little rice left be given to their British comrades; as for themselves, they could do with the *soup*, i. e., the water in which the rice had been boiled!

But the *ne plus ultra* of abstinence combined with robust strength is furnished in the record of Shamyl, the heroic Circassian, who for the last two years of the war that ended with his capture had nothing but water for his drink and roasted beechnuts for his food, and yet month after month defied the power of the Russian Empire in his na-

tive mountains, and repeatedly cut his way through the ranks of his would-be captors with the arm of a Hercules.

The philosophers of antiquity prided themselves on their frugal habits, which ranked next to godliness in their estimation, as expressed in the famous aphorism, "God needs nothing, and he is next to Him who can do with next to nothing"—whose material needs are the smallest. Primitive habits are certainly favorable to independence, especially in a genial climate, where a man is above the fear of tyranny and all social obligations, who like Shamyl can subsist on the spontaneous gifts of his mother Earth. "Do you know," Cyrus asked the ambassador of a luxurious potentate, "how invincible men are who can live on herbs and acorns?" If the Saracens had persisted in the simplicity of their fathers, the nineteenth century might see Moorish kingdoms in southern Europe, and Arabian science and fruit-gardens in the place of deserts and monkish besottedness. Cato needed no prophetic inspiration to predict the downfall of a city where a small fish could fetch a higher price than a fattened ox.

Lycurgus, the Spartan, makes the diet of his countrymen the subject of careful legislation, but seems to have feared excesses in quality rather than in quantity: as long as the black soup and other national dishes remained orthodox in regard to the prescribed simple ingredients, free indulgence of the most exacting appetites was not only permitted but encouraged. At the philosophic reunions of the Lyceum the bill of fare permitted a choice between dried figs and honey-water in addition to the wheat-bread, which could not be refused, and Greece was the model of early Roman institutions in this as well as in other respects. Fruit and bread-cakes, spiced with Attic salt and music, entertained the friends of Plato at those suppers of the gods of three or four hours, which Aristotle preferred to so many years on the throne of Persia; but the very next generation witnessed the drunken riots of Babylon and the general introduction of Persian manners and luxuries.

The ancients undoubtedly were our superiors in hygienic insight, but among the many judicious restrictions of their dietary regimens there are some that we must attribute to prejudice or leave utterly unaccounted for. The Mosaic interdiction of rabbit-flesh, wild swan, and finless fishes has been very learnedly explained as a necessary consequence of general laws, which had to include those animals for the sake of consistency; but what on earth or below earth could induce Pythagoras, the great philosopher, to prohibit the use of *beans*—nay, even denounce any contact with the shell, the leaves, or the roots of the poor plant as a dreadful pollution? Such was the stigma he had attached to the violation of this rule, we are told, that a body of soldiers from Magna Græcia, who all belonged to the Pythagorean sect, permitted themselves to be cut to pieces or captured rather than save themselves by crossing a bean-field!

The old proverb *de gustibus* can hardly prevent astonishment at the diversity of tastes. What would Pythagoras have said about our national dish of pork and beans, or what shall we say to explain the Japanese prejudice against milk, the Papuan's partiality for fat white caterpillars, or the *gliraria* that were attached to every decent household of imperial Rome? Athenæus describes a glirarium as a large brick structure, divided by wire partitions into small cells, from five hundred to two thousand of them; every cell the receptacle of a captive rat, which was fattened on husks, rotten fish, and other offal, till a further increase in bulk would make it difficult to extract the animal through the narrow door of its cage. The perfect specimens were then collected, stuffed with crushed figs, and served in a sauce of olive-oil at the banquets of wealthy patriots who preferred domestic delicacies to colonial imports. The Digger Indians of our Pacific slope rejoiced in the great locust-swarms of 1875 as in a gracious dispensation of the Great Spirit, and laid in a store of dried locust-powder for years to come. Even mineral substances and strong mineral poisons have their votaries. Mithridates, King of Pontus, could take a large dose of arsenic with impunity, and the mountaineers of Savoy and southern Switzerland use arsenic habitually as a safeguard against pulmonic affections. The poor Norsemen often mix their daily bread with a whitish mineral powder, more from necessity than a vitiated taste, we hope; but a similar substance is employed by the natives of Brazil and other parts of tropical America without any such excuse. The name of Panama is derived from *panamante* (originally *pan-de-monte*, mountain-bread), a substance which the Indians of Central America prepared from a mealy gypsum-powder, found here and there in the Sierra. Humboldt describes a tribe of Indians in northern Brazil who have been addicted to the use of panamante for generations, and were distinguished by a monstrous protuberance and induration of the upper abdomen. When the French were masters of St. Domingo their negro slaves had contracted a similar passion, and could only be restrained by barbarous punishments from indulging it to excess.

It would be erroneous to suppose that cannibalism has become quite extinct. Among the Dyaks of Borneo there is a recurrence of the outrage after every petty feud and raid, and many of the South Sea Islands are still infested with secret anthropophagi. The Pintos, an aboriginal tribe of Yucatan, have repeatedly been detected in cannibal practices; and phenomenal cases have occurred in Asia after every protracted famine. In 1873 the Chasseurs d'Afrique captured an old Kabyle on the plateau of Sidi-Belbez (Algiers), who had committed innumerable murders to indulge this horrible passion, and had twice been caught *in flagrante* by his countrymen, who contented themselves with giving him a good hiding the first time, and released him on another occasion when they found his victim had only been a French settler!

The slaughter-houses of every large city are visited by delicate ladies,

who hope to cure affections of the respiratory organs by a draught of fresh blood, but who would inspire a Hindoo with a cannibal terror more intense than that produced in the Algerian settlements by the above Kabyle. Herodotus relates that the Scythians executed their criminals by a potion of fresh ox-blood, and recommends this as a more humane method than capital punishment by the sword, though inferior to the hemlock-cup. "For opening the gates of Tartarus," says Haller, "there is nothing like a good narcotic. If I should have occasion to leave this world, I would no more think of shooting myself than of leaving town by being fired from a mortar, when I could take the stage-coach."

The Turks shudder at seeing a Frank swallow oysters, and even in the cities of Europe and North America we find individuals with similar antipathies; and I know an old professor who passed half a century in St. Petersburg, and suffered grievously from an unconquerable aversion to caviare. Caviare is the salted or pickled roe of the sturgeon—not quite so bad as Schnepfendreck, a North German delicacy, which consists chiefly of the fæces of the common woodcock.

Professor H. Letheby, food-analyst for the city of London, is responsible for the following account of a mandarin's dinner, given to an English party and some distinguished natives of Hong-Kong:

> The dinner began with hot wine, made from rice, and sweet biscuits of buckwheat. Then followed the first course of custards, preserved rice, fruits, salted earthworms, smoked fish and ham, Japan leather (?) and pigeons' eggs, having the shells softened by vinegar; all of which was cold. After this came sharks' fins, birds' nests, deer-sinews, and other dishes of an appetizing and dainty character. They were succeeded by more solid foods, as rice and curry, chopped bear's paws, mutton and beef cut into small cubes and floating in gravy; pork in various forms, the flesh of puppies and cats boiled in buffalo's milk; shantung or white cabbage and sweet potatoes; fowls split open, flattened and grilled, their livers floating in hot oil, and cooked eggs of various descriptions, containing embryo birds. But the surprise of the entertainment was yet to come. On the removal of some of the flower-vases a large covered dish was placed in the center of the table, and at a signal the cover was removed. The hospitable board immediately swarmed with juvenile crabs, who made their exodus from the vessel with surprising agility, for the crablets had been thrown into vinegar before the guests sat down, and this made them sprightly in their movements; but, fast as they ran, they were quickly seized by the nearest guests, who thrust them into their mouths and crushed them without ceremony, swallowing the strange gelatinous morsel with evident gusto. After this *soy* was handed round, which is a liquor made from a Japan bean, and is intended to revive the jaded palate. Various kinds of shell and fresh fish followed, succeeded by several thin broths. The banquet was concluded by the costly bird's-nest soup, the dessert being a variety of scorched seeds and nuts, with sundry hot wines and tea.

But the mandarin was astonished in his turn by finding ice-cream among the delicacies of an English refreshment-table, and predicted disastrous consequences from its habitual use. Ice, without doubt, is in-

jurious, but not more unnatural than our custom of swallowing boiling-hot soups and stews.

In the use of hot spices the Spaniards and their South American kinsmen exceed every other nation. *Chilé colorado*, or red pepper, is one of the mildest condiments of a Peruvian kitchen. The *yerba blanca*, a whitish-green herb which is used raw with olive-oil on sandwiches, and enters into the composition of various ragouts, is described as resembling the *lapis infernalis* in its effect on a normal tongue. A Mexican can chew up a handful of red pepper as we would so much dried fruit, and eats onions, garlic, and salted radishes as a relief from more pungent tastes. I must believe it, on the testimony of the entire medical faculty of the city of Bremen, that a man who was treated in their city hospital for a most mysterious complaint settled the dispute of his physicians by confessing a weakness for *tan-water*—the fiery infusion of tan-bark, in which he had indulged rather to excess in the last year. The inhabitants of southern Russia, especially of the Dnieper Delta, are all day long chewing the aromatic seeds of the sunflower and different kinds of pumpkin-seeds, which appears to be less a stimulation than an idle habit, like the use of chewing gum in our boarding-schools.

Timour the Tartar celebrated his victories by solemn barbecues of broiled horseflesh and fermented mare's milk, or koumiss, which is still a favorite drink of his countrymen. Tartars also use a decoction of the poisonous fly-sponge as a stimulating beverage, and according to Vambéry have a national foible for morsels of superannuated meat, of an aroma which the French term of *haut-goût* would hardly begin to describe. Yet these same Tartars might shudder at being confronted with a dish of that Limburg delicacy which finds its way into the best hotels of Continental Europe. I can not forget the emphatic protest of a Spanish officer who was invited to partake by a German admirer of the questionable dainty, in the cabin of a Havana steamer. "You think it unhealthy to eat that?" inquired the Hamburger, in polite astonishment. "Unhealthy?" exclaimed the Hidalgo, with a withering look and a gasp for a more adequate word—"no, sir! I think it an unnatural crime!"

THE MONSTROUS IN ART.

By SAMUEL KNEELAND, A. M., M. D.

MANY persons of culture and poetic imagination, with a keen sense of the beautiful, but with little knowledge of living nature, believe and maintain, and in one sense justly, that certain works of old and modern masters are works of high art, from color, grouping, elegance of figures, and the various accessories which, in themselves, or by ideas and emotions excited by them, make painting and sculpture very powerful agents in instructing and elevating man-

kind. According to a recent definition of art, that of Mr. Benjamin, "Art may be said, in a general way, to spring from the poetic yearnings and emotions suggested by aspirations after the true, the good, and the beautiful . . . . the material means for expressing such feelings appealing to the imagination through the eye by the use of external forms." The highest art, according to this definition, must include the good, the true, *and* the beautiful; the physically beautiful, or the beautiful and the good, is not the aim of the highest art; the true must be added for a work that shall rank *as* such for all time.

A painting or a statue may be beautiful, as interpreting the emotions or religious beliefs of man at any particular epoch of his history; but, if the ideas symbolized or suggested become untrue or unbeliefs, they thereby lose in artistic value, and no longer belong to the domain of the *highest* art. Nothing that is simply temporary, no mere conventionalism, however beautiful at the time, which becomes unnatural or impossible as man advances in knowledge, can, in my opinion, belong to the *highest* art.

Any one who discusses the principles of art from the point of view of the true, without reference to the beautiful, labors under great disadvantages, arising chiefly from the intimate connection between art and religion. Most of the best works of the old and modern masters, in painting especially, embody the theologic beliefs of the period, and suggest ideas of spiritual, not of physical truth. As there is evolution in nature and in theology, let us hope there is also evolution in art; we can not stand still in any matters of knowledge, for, if we go not forward, we practically go backward, as all the interests of humanity will leave us behind.

The faith in spiritual truths which artists embody by symbols, without being of necessity weakened, will be modified by knowledge, and thus render forms once suggestive of beauty and goodness now untrue and monstrous. I know that the old objection will be urged that, though *scientific* truths rest upon *reason*, there are *spiritual* truths incapable of demonstration, emotions above and beyond reason. Even educated persons have very indefinite and very different ideas on the nature of the mental evidence arising from religious aspirations, and the wish is very apt to be "father to the thought" in symbolic representations of supernatural attributes and powers.

There may be no contradiction in the belief in the existence of spiritual beings far above us in power, and that such may even communicate with mankind in various ways; but, if they assume to the eye the shape and functions of humanity, they should be made to conform to the laws of human anatomy and physiology.

Those who are easily and strongly moved by these *spiritual* emotions will not listen to *reason*, which they maintain has nothing to do in the premises. Let such cling to their spiritual truths, and to the artistic representations which embody and suggest them, and regard

them as high art if they please ; but, at the same time, let the truth as it is in nature and reason have a chance to appear in the field of art. If Theology and Art are sisters (and they are in one sense), let them be *twin* sisters, walking hand in hand, with the stamp of truth, as we know it, in every line, word, and feature, irrespective of any pious frauds or false rules of art bequeathed to us by past ages. Spiritual truth ought to be reënforced by scientific truth, and art as well as religion will be the gainer.

I know very well that I am treading here on debatable ground, and that those who follow, or think they follow, the *ideal* in art, will rise as a host against me. My object here is to show that art has too much neglected the laws of living animal nature ; that mythology has been followed rather than zoölogy, where attention to the latter would have been just as good for all the purposes of art, and far better for the interest of truth. In one sense, the *ideal* is the ultimate aim of art, if by that is meant that it shall suggest true ideas, and excite emotions which shall educate and elevate ; but not, if by the ideal we signify the merely imaginary, fanciful, unnatural, and impossible, however beautiful such creations may be.

Even admitting that a work of high art by the *old* masters may include the impossible, the unnatural, as symbolic, if judged by the knowledge of the times and the motives of the artist, that is no reason for advocating similar errors in the nineteenth century. It seems to me that the symbolic in art bears a relation to the natural and the true, similar to that which the hieroglyphics of the ancient Egyptians do to the written languages of the moderns—the one indefinite, suggestive, but variously interpreted, local, and temporary ; the other definite, positive, universal, and for all time unmistakable—and that we might as well go back centuries and adopt the hieroglyphic as the simply symbolic without reference to its truth in art. Symbolism is the visible expression of a myth, possessing a variable amount of truth and a large amount of error ; both are characteristic, in the progress of civilization, of the lower phases of development.

I speak of art from the *natural*, not the *imaginative* point of view, and my arguments are addressed chiefly to such as have a fair knowledge of anatomy, physiology, zoölogy (living and fossil), and the laws of development in the animal kingdom. As, however, many deeply interested in the progress of art have very little acquaintance with living nature, it will be necessary for me to enter into some details, tiresome perhaps for the scientific expert, but important for the popular understanding of my argument.

While I do not deny the artistic value of the imaginative, symbolic, and ideal, I maintain that such, at the present time, if contrary to nature, is not the *highest* art, is not necessary for the expression of the most ennobling ideas, and is not demanded by the most exalted aspirations of humanity.

The Greeks and Romans, whose principles of art the moderns have chiefly imitated, personified certain ideas of their social state, deified and worshiped them. As a general rule, they found in nature the types which they idealized; in some cases, from ignorance, superstition, or love of the marvelous, they departed from nature, and to that extent, in my judgment, their art was false. Art, as I understand it, should be the interpreter of nature, without too servile an imitation; art may transfigure nature, but should never be false to it; *un*natural and, I may add (as far as knowledge is concerned), *super*natural art is *monstrosity*.

By *monstrosity* (which is here used in its scientific, not its popular sense) I mean nothing ugly, misshapen, gigantic, or dwarfish, or with any congenital anomalies of conformation, rendering impossible the accomplishment of the ordinary functions of life, but the union of parts incompatible with each other, and impossible when brought to the test of reason and natural laws, however beautiful or suggestive they may be, and however consecrated by unquestioning ages of social, religious, and æsthetic acceptance. It is true, as Goethe has well said, that "it is in her monstrosities that Nature reveals to us her secrets," which we now know are but the expressions of natural laws; I hope to show that in the monsters of art she only reveals to us her weakness.

To illustrate my meaning by a few examples: The ancients, when they represented Saturn as Chronos or Time, the father of the gods, as an old man devouring his children (hours and days and years), armed with a scythe by which he cut down the generations of man, conceived a beautiful, expressive, and natural idea; but when they put upon him a pair of wings, to indicate the velocity of his flight, he became a monster, for the reason that arms *and* wings *and* legs are incompatible, and can not exist in nature, as we know the vertebrate skeleton. Six pairs of *limbs* are conceivable with the vertebrate skeleton, but wings without bones to support or muscles to move them are not conceivable.

Among other winged and impossible monsters created by ancient art, expressing long-cherished ideas, is Cupid or Love — though it would be an anatomical impossibility to move said wings; he must drop either his arms, with the bow and arrows, or his wings. So Mors or Death, represented by a skeleton, has enormous wings, with not a muscle to move either bone or pinion; Morpheus the minister of Somnus or Sleep, Psyche the Soul, and Zephyr the West Wind, have the wings of a butterfly—a mixture of vertebrate and invertebrate characters entirely incompatible.

The wonderful adaptation of the human skeleton to its uses—the contour of the spine, which renders erect position and biped locomotion possible in him alone of mammals; the lower limbs for locomotion only; the upper limbs for prehension, and the service of the senses resident in the head—all these imply a certain bony structure and corresponding muscular developments. If you add another pair of limbs as wings,

you make an anatomical nondescript, an impossible monster, devoid of truth, false to nature, odious to the highest art.

The smooth, comparatively hairless skin of man, angel, or devil, is incompatible with the feathers of a bird's wings; his bony tissue has not the air-spaces, nor does it communicate with the lungs, as in the bird, which is thus rendered specifically lighter. His thorax or chest is too movable for the support of muscles of flight, even if angels were made armless and winged; his breastbone is smooth, not keeled as in birds; so that flying angels must of necessity be deformed and pigeon-breasted if they had muscles of flight. The biped attitude of the bird requires a change of posture, an horizontality, to get the center of gravity between the shoulders for flight, which would render man a ridiculous figure. As far as we know locomotion in the animal kingdom, the wings and the legs are not moved at the same time in progression in the air; it is seen only in some birds with very rudimentary or short wings, who use their wings to help them in running on the ground, which is not the ideal of the artist's angel. The ideal, or that which suggests the idea of a heavenly messenger, need not be false to nature; an angel *without* wings is just as ideal and suggestive, and not an anatomical impossibility. That the form of an angel need not of necessity have wings is shown by a painting in the museum at Naples of the "Holy Family," attributed to an artist of the Florentine school, in every respect admirable, and usually called the "Virgin of Purity." The angels have no wings, and carry lilies in their hands; wings would have added nothing to the picture, which is remarkable for its natural beauty.

It seems to me that an angel *without* wings, floating upon surrounding clouds (like the "hours" in Guido's "Aurora"), is a much higher symbol of a supernatural messenger than the conventional winged one; it indicates a spirit, an ethereal substance, a mere outline figure suggestive of motion; but if you add the unnatural and impossible wings to the arms, you make a monster in human form, defy the process of reasoning, rob the image of its spirituality, and degrade it to a coarse and earthy symbol, inconsistent with the idea it is intended to convey.

I will allude to a few other monstrosities in ancient art, copied by the moderns, to further illustrate my meaning.

It was natural that a barbarous people, at the first and distant view of men on horseback, should imagine that they were creatures half man and half horse; hence the fabled Centaurs, a people of Thessaly, who were among the earliest to bring the horse into the service of man. As is well known, the Centaurs had the head, arms, chest, and body of a man as far as the hips, joined to the chest, body, and four limbs of the horse. Though a Centaur *at rest* is a noble figure, symbolic of strength, swiftness, intelligence, and protection of man by the Olympian gods, the position which the creature was supposed to assume in his contact with man, as shown in many mural tablets found at Pompeii, and now in the museum at Naples, is ridiculous and impossible.

Just imagine, if you can, the condition and position of the organs in this case. Let it be all right to the point where the horse joins the man; the excretions of the man, with his mass of intestines and other organs of digestion and secretion, must pass through the chest of the horse, filled with this creature's lungs and heart and great blood-vessels, involving another set of digestive and excretory organs, another form of skeleton, with the muscles, limbs, and skin of the horse. The man must eat for the horse, as his is the only mouth, which would necessitate a diet repugnant even to the most fanatic vegetarian. We naturally inquire if he must also breathe for the horse; there must be double lungs, double heart, double stomach, double intestines, double body, six limbs, long tail, hoofs and hands—a monster considerably worse than the single-bodied but six-limbed art-angels above alluded to. If we accept Hercules and Achilles, we can not accept the Centaur Chiron, their instructor.

Among other monsters created by the ancients and adopted by the moderns is Pan, the chief of the rural deities, with his attendant Fauns and Satyrs, having the head, arms, and body of a man, and the hairy lower limbs and hoofs of a goat. How they managed to walk erect on such feet, and preserve their center of gravity where it ought to be, to say nothing of the incompatibility of the human pelvis and the hircine legs in bones and muscles, is a puzzle for the physiologist. The fact that the theologic devil is usually represented very much like the god Pan, with all his inconsistencies and impossibilities, shows at once the origin and the absurdity of the idea; to his extreme ugliness, exciting a *panic* fear, is doubtless due the selection of his figure to represent the theologic spirit of evil, upon whose existence and domain many a *spiritual panic* has rested.

Neptune, the god of the seas, was represented in an immense shell drawn by impossible sea-horses, and surrounded by equally impossible Tritons, half man and half dolphin, and Nereids, half woman and half fish.

There is a large class of ancient artistic conceptions, freely copied by the moderns, not anatomically monstrous, but physically and physiologically impossible—such as Atlas supporting the globe on his shoulders; caryatides, female figures used by architects to support roofs and heavy weights; and other similar conceptions, painful to look at if we apply the tests of reason and common sense. I would say here that, in mere ornamentation, conventional representations suggestive of the intended image may be legitimately and artistically used with good effect; but if they are contrary to nature, whether on a candlestick or a church tower, they must belong to the *lower* spheres of art; and no metaphysical subtilty, no assumption of æsthetic culture, no aspirations after an imaginary and impossible ideal, ought, in this nineteenth century, to raise them to the highest position in art.

As the so-called ideals of the ancients must have had some things in

nature to suggest them, it may be well to examine, in the light of the present day, for *their* justification, but not for *ours* (who have copied them and ought to have known better), what they really had as foundation for these monstrous forms in truth, real or apparent.

The conception of the Centaurs, we have already seen, is easily explained by the appearance of a man on horseback. Workers in metals, exposed to the intense heat and glare of their fires, would naturally protect their faces by masks of wood or leather, as makers of plate-glass, for example, do now, looking out through a single median hole—hence the fabulous Cyclops. The Satyrs were evidently derived from some of the large anthropoid apes, which must have been known to primeval man.

The above-mentioned monsters, and many others which admit of a natural explanation, did not originate with the Greeks; they obtained them from the Egyptians, and these from antecedent races long before the historic period. The existence of man with the mammoth, mastodon, Irish elk, cave bear and lion, among quadrupeds—with the dodo, dinornis, and epiornis, among birds—suggests that perhaps he may have lived with the pterodactyl and serpent-like marine lizards, or their modified descendants, in the Tertiary or a more remote epoch. The mastodon, or the mammoth (either), might easily have been made into the Minotaur killed by Theseus; the Nemean lion slain by Hercules may well have been the *Felis spelæa* of the bone-caves; the rhinoceros would make an excellent foundation for the unicorn; the cuttle-fishes of the Mediterranean, with their eight or ten arms, moving independently, and armed with terrible suckers, would readily suggest the many-headed hydra, also killed by Hercules.

The Sirens, and other marine creatures of human likeness, are the natural outgrowths of the imagination of sailors returning from long voyages, without the sight of a woman for months or years. Seeing manatees and seals reclining on the shores, holding their young in their arms while suckling them, like all mammals, the semi-human faces, the womanly position, and the tender care and anxiety for their young in this act—their hearts would be filled with such joy at thoughts of home, and their eyes with tears long pent up, that the combination of indistinct vision and excited imagination would transform the creatures they saw into the beautiful women they longed to see.

At Stabiæ have been found mural tablets representing Nereids, or horses with the tail of a fish, evidently suggested by the little sea-horse (*hippocampus*) of the Mediterranean; in some the head of the horse is replaced by the head of a tiger—not a very abrupt transition.

The fauna of the Tertiary age from the Miocene down, which there is some reason to believe passed before the eyes of primeval man, would afford ample material for gorgons, dragons, sylphs, and satyrs, leviathan and behemoth, and the whole list of ancient and modern fabulous monsters. The birds with teeth, and the winged lizard of the Secondary

age (the pterodactyl), known very well by its fossil remains, if clothed with flesh and provided with limbs and wings, would make a creature in some respects like the dragon of fairy tales.

The mythical gigantic kraken of the northern seas has a legitimate descendant, and is simply an exaggerated type of the giant *architeuthis* of the coast of Newfoundland, of which a specimen has recently been exhibited in this city.

The "roc' of Sindbad the Sailor was not much larger than the epiornis of Madagascar and the dinornis of New Zealand, more than twice the size of the ostrich. The Eastern imagination, on the basis of these great birds actually coexisting with man, would naturally put on the wings which birds of this type did not possess, and then the transportation of a man into the "Valley of Diamonds" would be quite possible.

These forms could hardly have been imagined by barbarous man; they must have had their prototypes in nature: they are, therefore, not *ideal* forms, but, in a zoölogical sense, *real* forms.

An artist may be ignorant of history, chronology, and zoölogy, as well as of anatomy and physiology, and may be a perfect child in his knowledge of common things beyond his immediate every-day sight. Even Raphael, Albert Dürer, Salvator Rosa, Vandyke, Paul Veronese, Poussin, and many others, have greatly erred in these respects. Instances might easily be mentioned, but I will merely allude to them to show that art has not always been true to nature and fact, and to say that we are not only at liberty, but in duty bound, to protest against all untruthfulness, whether it offend the eye or the reason.

Let me not be understood as pretending to say that there is *no art* or beauty in purely fanciful creations in painting or sculpture. There is a place, and a genuine one, for the allegorical, the symbolic, the mysterious, the unreal, if you will, in art; but such art, from the very fact of its unreality, untruthfulness, and impossibility, is, I maintain, a *lower* type than that which is strictly natural and true. Wings of angels, as messengers of glad tidings or guardian spirits, are, as fanciful creations, beautiful, though untrue; winged heads, as suggesting the swiftness of thought and intelligence, are acceptable as symbolic, though impossible: but all such creations should take a subordinate position in art, and in proportion as the symbolism departs from the true, the known, and the conceivable. We must not confound the results of the imagination, which exaggerates possible parts seen, or supposed to be seen, in nature, with the wholly unreal products of the fancy; we may admit their beauty, but, however definite and pleasing their outlines, if their combinations, when tested by reason, are impossible, they must be regarded as lower than the natural. They may answer for gas-fixtures, monuments, memorial windows, and various articles of household decoration, but not for anything demanding admiration and following as a work of *high* art.

Let me now bring to your remembrance a few celebrated works of

acknowledged art, to show my meaning more clearly, and to give direction to the criticisms which I wish to make.

The Sistine Madonna of Raphael is without doubt the best and most admired representation of "motherhood" in the whole range of art. I think the experience of most persons who have seen it, even in engravings or photographs, will justify the assertion that they are so carried away by the beauty and grace of the mother and child, that they do not at first see the host of surrounding angelic heads, nor the two "cherubs" at the bottom of the picture. I allude here only to the latter, which, in my opinion, detract from the grand effect, and introduce a disturbing and inferior element which had better been left out. The expression of their faces is innocent, angelic, if you please; the attitudes are graceful, natural, and childlike; nevertheless, they are unnecessary, impossible creatures, and are, if anything, six-limbed or hexapod vertebrates, when, as naturally formed children, they would have been just as symbolic, though quite as insignificant and useless. Though their parts, separately, exist in nature, as a combination they are impossible, and therefore, except as misplaced symbols, not artistic.

In this connection I would remark that, in my opinion, man has never imagined, and can never imagine, any symbolic form in art or poetry not suggested by his surroundings; there are ugly things enough and beautiful things enough in nature to suggest any forms represented by art; but a compound of man and bird or beast or insect could never be suggested as a *whole*, without a previous knowledge of the *parts*.

It is not a very great step from the Aphrodite and Eros of the early Greeks (not the sensual Venus and Cupid of the later Greeks and the Romans), by which they represented all that was tender and lovable in woman, to the Virgin and Child. The step is still less from Cybele or Rhea, the wife of Saturn and the mother of Jupiter or Jove, whose name was in Greek *Theotokos*, in Latin *Deipara*, meaning the "mother of God"; Jove, the king of the gods, suggests in name as well as attributes the Hebrew Jehovah. The Madonna, it seems to me, is simply an evolution from pagan mythology to Christian art.

In some old religious paintings angels are represented as winged heads, without body or limbs. Now, these artists painted better than they knew; for, according to the acknowledged principles of philosophical and comparative anatomy, the anterior limbs, whether arms, wings, legs, or fins, are appendages to the occipital or posterior vertebra of the skull; in the fish, in fact, the pectoral fins, the anterior limbs, are attached by bony connection to the back part of the skull. But, though winged heads are anatomically legitimate, physiologically we can not understand the action or the origin of any muscles sufficiently powerful to move the head, to say nothing of the other incongruities, especially of the union of human hair, face, and skin with the feathers of a bird. As pure symbols these are acceptable for the infancy of the human race, but are not therefore to be perpetuated by the moderns. Mother Goose

is well enough for the child, but distasteful and absurd for the man, even though under its symbolic language much truth be hidden.

In modern art, the "Night" and "Day" by Thorwaldsen, so well known and so much admired, are similar specimens of the "Monstrous in Art"; the symbolic beauty of the work is such that we do not notice the untruth and the impossibility of the wings. The "Theseus slaying the Centaur," by Canova, displays another form of six-limbed monster, whose impossibility is evident after what has been said above, without the excuse of symbolism. In all our large cities we find symbolic paintings of an "angel overcoming Lucifer," in which are seen the same feathery pinions, widely spread and in violent action, with no possible means for their support or movement.

Here, as in many paintings and statues which will readily be brought to mind, as in the wall decorations at Pompeii, the "Victories," etc., we see a pretense of motion more or less active, and a possible use for wings could they exist. But what shall be said of the large and conspicuous tablets at the corners of the "Museum of Fine Arts" in Boston, in one of which the central and principal figure, styled the "Genius of Art," and so indicated by letters, is one of these impossible winged monsters?

The idea, however, is not original, but is an imitation of ancient art, in which a genius or tutelar god of man or his industries is usually represented with wings as well as arms.

In the above-mentioned tablet we see a nude figure, seated comfortably upon a chair, presumably quiet, with outstretched arms welcoming the nations who are bringing their representative works as offerings at the shrine of art; and yet this "Genius of Art," not content with arms and legs, *at rest*, has immense outstretched wings, indicative, if of anything, of active *motion*—anatomically, an impossible six-limbed creature; physiologically, an absurdity, implying the contradictory states of rest and motion at the same time; and, therefore, artistically, an unnatural, nondescript monster. A similar tablet is upon the other corner, if possible, more ridiculous than the first; the genius of art has found a winged brother monster, called "Industry." The two, each with wings and arms, are quietly seated, with wings widely stretched—we see in this the same anatomical impossibility, the same physiological absurdity, the same degradation of symbolism. As man is never intentionally absurd, let us attribute these and similar monstrosities to ignorance of nature's laws. If this be art, there is no gulf of absurdity too wide for symbolism to clear at a single bound.

Other winged angelic hexapods may be seen at each corner of the tower of the church on Commonwealth Avenue, with trumpets at their mouths; it is difficult to see how the wings in this case add anything but the ludicrous.

No permanence of embryonic conditions—no excess of growth, no union of parts of more than one individual—can explain or justify these

and similar monsters; and surely no rules of art can demand the continued perpetration of such absurdities, in painting or sculpture, even as symbols.

In my opinion, then, there can be no high art, as there is no truth and no real significance, in external forms unknown to anatomy and physiology; truth in art must not be divorced from truth in science, nor the truly beautiful from nature. The exterior should translate, as it were, the interior; and, whether we study the human or the animal figure, from the point of view of surgery, art, or philosophical anatomy, the natural type, the laws of structure and growth, the correlation and the organic harmony of parts, should in every case lie at the foundation. The idealism of *ancient* art is, I believe, a pretense of the moderns; their *ideal* is the *real, magnified* by the *imagination*. The *modern* ideal of much that is considered high art is too often the impossible, the absurd, the monstrous, the incomprehensible.

The conscientious and real artist, though he may be ignorant of, despises not anatomy; it is only the superficial and the conceited who fancy that it is a laudable and independent spirit which allows imagination, under the pretense of symbolism, unguided by knowledge, to dictate the rules of art. Albert Dürer, Leonardo da Vinci, Jean Cousin, were well versed in anatomy; it would have been better had the genius and imagination of Raphael and other great artists been tempered by an accurate knowledge of the real.

Herbert Spencer says, "Only when genius is married to science can the highest results be achieved"; to which Mr. Benjamin adds, in his essay already quoted, "But such science should be the intense study of nature even more than of art."

In our day, when reason is supreme, the thinking world can not be made to believe that *progress* means *evil*, even though it modify ideas of things once considered sacred and beyond reason; and any belief, practice, sentiment, or influence, which can not bear the light of reason, and hence can not be said to be founded on truth, deserves to be removed as a bar to human progress.

It has been said, and no doubt truly, that as *knowledge increases*, the *imagination decreases*; in such an event our ideal will soon become the real, without exaggeration, and nature and art will no longer be divorced, even in appearance. Increasing intelligence is the great and never-ceasing iconoclast which breaks to pieces the images created by imperfect knowledge of facts.

This is about the sum of the arguments in favor of symbols, once suggestive of the good and the sacred, but since proved to be fallacious and founded on error, namely, that those who originated and used them for purposes of good believed them to be true and beautiful, and therefore that for all time, or at the present time, they are worthy of imitation and belong in the realm of high art.

Must we, then, give up our saints, angels, and devils, and other

venerable, beautiful, and ugly monsters in art, so endeared by childish memories and fears? United to and supported by ignorance and blind belief, they stood as truths in the infancy of the race; separated from these, and subjected to the light of reason and knowledge, they fall from our acceptance as beliefs, and from the highest sphere of art, where nature and truth should henceforth be the grand aims of the artist.

Should any object that following strictly the laws of nature will have a tendency to lower the aspirations of the artist, we may refer to a sister science in defense of our position. The signs of the times have convinced many a timid but reasoning soul that fidelity to truth and nature can never injure religion, however much it may shatter ideal theologies; nor in art can it injure anything but the false and the temporary—the grand underlying principles resting on the basis of eternal truth. Are we not justified, then, in saying, "The essentially beautiful must be in nature; it can not be beyond it, above it, nor below it; the *merely ideal in form* can have no real existence in the mind of man"?

NEW GUINEA AND ITS INHABITANTS.

By ALFRED RUSSEL WALLACE.

I.

IMMEDIATELY north of Australia, and separated from it at Torres Straits by less than a hundred miles of sea, is the largest island on the globe—New Guinea, a country of surpassing interest, whether as regards its natural productions or its human inhabitants, but which remains to this day less known than any accessible portion of the earth's surface. Within the last few years considerable attention has been attracted toward it by surveys which have completed our knowledge of its outline and dimensions, by the settlement of English missionaries on its southern coasts, by the explorations of several European naturalists, and by the visits of Australian miners attracted by the alleged discovery of gold in the sands of its rivers. From these various sources there has resulted a somewhat sudden increase in our still scanty knowledge of this hitherto unknown land; and we therefore propose to give a general sketch of the island and of the peculiar forms of life that inhabit it, and to discuss briefly some of the interesting problems connected with its indigenous races.

It has hitherto been the custom of geographers to give the palm to Borneo as the largest island in the world, but this is decidedly an error. A careful estimate, founded on the most recent maps, shows that New Guinea is considerably the larger, and must for the future be accorded the first place. In shape this island differs greatly from Borneo, being

irregular and much extended in a north-northwest and south-southeast direction, so that its greatest length is little short of 1,500 miles, a distance as great as the whole width of Australia from Adelaide to Port Darwin, or of Europe from London to Constantinople. Its greatest width is 410 miles; and, omitting the great peninsulas which form its two extremities, the central mass is about 700 miles long, with an average width of 320 miles, a country about the size of the Austrian Empire, and, with the exception of the course of one large river, an absolute blank upon our maps.

This almost total ignorance is the more remarkable when we consider how long the country has been known, and how frequently its shores have been visited. It was discovered in 1511, even earlier than Australia, and from that time Spanish, Portuguese, Dutch, French, and English vessels have continually passed along its coasts. Most of our early navigators—Forrest, Dampier, and Cook—visited New Guinea, and have given us some account of its inhabitants; while, more recently, many exploring and surveying ships—the Coquille and Astrolabe, under French; the Rattlesnake, Fly, and Basilisk, under English; the Triton and Etna, under Dutch commanders—have added to our store of information. Among private naturalists and explorers, the present writer was the first to reside some months in New Guinea in 1858; since which time Dr. Miklucho Maclay, a Russian; Dr. Beccari and Signor d'Albertis, Italians; Dr. A. B. Meyer, a German; Mr. Octavius C. Stone, and several English missionaries—have all made important explorations and added much to our knowledge of the natural productions of the island and of the tribes residing on or near its coasts.

From these various sources we have obtained a tolerable knowledge of the outside margin of the country, but never extending more than twenty miles inland, except in the case of the Fly River, which Signor d'Albertis ascended for nearly 500 miles, reaching a point somewhat beyond the center of the island. The northwestern and southwestern peninsulas of New Guinea are the best-known portions, and both seem to be mountainous throughout. In the north, Mount Arfak, a little beyond Dorey Harbor, is from 8,000 to 10,000 feet high, while in the southeast the Owen Stanley Range has several peaks which reach elevations of from 10,000 to 13,000 feet. The Charles Louis Mountains, commencing near the south coast, east of Triton Bay, appear to run far in a southeasterly direction, and their summits are believed to be snow-clad, and are probably at least 18,000 feet high. If they continue eastward in the same general direction they would pass about 100 miles to the north of D'Albertis's farthest point on the Fly River, and perhaps form a great curve till they merge in the Owen Stanley Range in the southeast. This, however, is mere conjecture, for throughout the whole course of the Fly River the land was low, and only on one occasion were high mountains seen to the northwest. Combining this with the

fact that for a length of nearly 700 miles the south coast of New Guinea is low and swampy, with no high land anywhere visible, we are led to conclude that there is probably a continuous range of lofty mountains toward the north, while the south consists of wide alluvial tracts and of slightly elevated inland plains. This part of the island would thus somewhat resemble Sumatra turned round, but with higher mountains, which are probably not volcanic, and with a considerably greater width of land.

Although the Fly River penetrates so far into the interior, its size and depth in its upper portion are by no means what we should expect in a stream fed by a lofty mountain range close to the equator. It is therefore almost certain that larger rivers exist farther west; while another large river certainly flows northward, having its mouth in a delta at the eastern extremity of Geelvink Bay. Until these rivers are explored, and at least the lower slopes of the hills ascended, we can not be said to have much real knowledge of the interior of New Guinea.

Situated close to the equator, and extending only eleven degrees south of it, the climate of New Guinea is hot and uniform, and the rains abundant; leading here, as elsewhere in similar situations, to the growth of a luxuriant forest vegetation, which clothes hill and valley with an ever-verdant mantle. Only on the coasts nearest to Australia, and probably influenced by the dry winds from that continent, are there any open or thinly wooded spaces, and here alone do we find some approach to the Australian type of vegetation in the occurrence of numerous eucalypti and acacias. Everywhere else, however, even in the extreme southeast peninsula and adjacent islands, the vegetation is essentially Malayan; but Dr. Beccari, who collected plants extensively in the northwestern peninsula and its islands, was disappointed, both as regards its variety and novelty. On the Arfak Mountains, however, he found a very interesting subalpine or temperate flora, consisting of araucarias, rhododendrons, vacciniums, umbelliferæ, and the antarctic genus *Drimys*. The forests of New Guinea are everywhere grand and luxuriant, rivaling those of Borneo and Brazil in the beauty of their forms of vegetable life; and we can not consider the collections yet made as affording more than very imperfect samples of the treasures they contain.

The animal life of this great island is better known, and is perhaps more interesting. Its terrestrial mammalia are, however, singularly few, and, with the exception of a peculiar kind of wild pig, all belong to the marsupial tribe or the still lower monotremes of Australia. The tigers, apes, and buffaloes, described in the fictitious travels of Captain Lawson, are here as much out of their real place as they would be in the Highlands of Scotland; while the tracks of large animals, supposed to be rhinoceros or wild cattle, actually discovered by recent travelers, are now ascertained to be those of the cassowary, which, so far as we yet know, is the largest land-animal of New Guinea. Large birds

were also seen and heard, whose spread of wing was estimated at sixteen or twenty feet, and which beat the air with a sound compared to the puff of a locomotive; but these are found to be only a well-known hornbill of very moderate dimensions. In place of these myths, however, we have some very interesting realities, the most remarkable, perhaps, being the tree-climbing kangaroos of rather large size, which, although but slightly different in external form from the jumping ground-kangaroos of Australia, hop about among the larger branches of trees, on the leaves of which they feed. They have a bushy tail, with somewhat shorter hind legs and more curved claws than their allies; and they afford a curious example of the adaptation of an animal to new conditions of life very different from those for which its general form and structure seem to fit it. Such a modification may, perhaps, be traced to a somewhat recent separation of Australia and New Guinea, when the kangaroos which remained in the latter country, not finding a sufficiency of herbage for their support in the dense forests, began to feed upon leaves, and ultimately became adapted, with as little change as possible, to a truly arboreal life. The entire absence of beasts of prey would favor this adaptation, as the coincident acquisition of swiftness of motion or powers of concealment is thus rendered unnecessary; and the tree-kangaroo accordingly remains a slow-moving creature, just able to get its own living, but in all probability quite unable to cope either with enemies or competitors.

The birds, like the mammalia, are mostly of Australian types, but nevertheless present many peculiarities. Most celebrated of all are the birds of paradise, forming a distinct family, containing more than twenty-five different species, all confined to this island and the immediately surrounding lands. These singular birds are really allied to our crows and magpies, but are remarkable for their special and varied developments of plumage. In most cases tufts of feathers spring from the sides of the body or breast, forming fans, or shields, or trains of extreme beauty. Others have glossy mantles or arched plumes over the back, strange crests on the head, or long and wire-like tail-feathers. These varied appendages exhibit corresponding varieties of color. The long trains of waving plumes are golden yellow or rich crimson, the breast-shields, mantles, and crests are often of the most intense metallic blue or green, while the general body plumage is either a rich chocolate brown or deep velvety black. All these birds are exceedingly active and vivacious, the males meeting together in rivalry to display their gorgeous plumage, while in every case the female birds are unornamented, and are usually plain or positively dingy in their coloring. From an unknown antiquity the natives of New Guinea have been accustomed to preserve the skins of these beautiful birds, and barter them with the Malay traders, by whom they are universally known as "burong mati," or dead birds, because they had never seen them alive. As the natives used always to cut off the feet in order to preserve them

more easily, the Malay and Chinese traders concluded that they had none; and all sorts of stories were told about their living continually on the wing, and being, in fact, birds of heaven, whence originated the names of "birds of paradise" and "birds of the sun" given them by the early Portuguese and Dutch writers. Down to 1760 the skins of these birds never reached Europe with feet attached to them, and the great Linnæus recorded the fact by naming the largest kind *Paradisea apoda*, or footless bird of paradise, a name by which it is still known among men of science. The natives also generally cut off the wings, so as to give greater prominence to the ornamental feathers; and this gives the birds an altogether different appearance from what they really possess in a living state, or when properly preserved.

By far the greater number of these birds, and those of the richest colors and most remarkable plumage, live on the mainland of New Guinea, and they are especially abundant in the mountains of the northwestern peninsula, where the Italian and German naturalists already referred to obtained fine specimens of all the known kinds. In the southeast one new species has been discovered, but only two or three sorts are found there; and as they are also in little variety in the lowland districts of the northwest, it becomes pretty certain that they are more especially mountain birds. We may therefore confidently expect that, when the great ranges of the interior are visited and explored by naturalists, other and perhaps still more wonderful species will be discovered. It is interesting to note that, with the exception of one very peculiar species discovered by myself in the Moluccas, all the birds of paradise are found within the hundred-fathom line around New Guinea, and therefore on lands which have probably been connected with it at a comparatively recent period.

Why such wonderful birds should have been developed here and nowhere else is a mystery we shall perhaps never completely solve; but it is probably connected with the absence of the higher types of mammalia, and with the protection afforded by luxuriant equatorial forests. The only other country in which similar strange developments of plumage and equally superb colors are found is equatorial America, where somewhat similar conditions prevail, and where mammalia of a low grade of organization have long predominated. Whatever may be the causes at work, their action has not been restricted to the paradise-birds. Nowhere else in the world are *pigeons* and *parrots* so numerous and so beautiful as in New Guinea. The great crowned pigeons, the largest of the whole family and rivaling the largest game-birds, were first described by Dampier as "a stately land-fowl about the size of the dunghill cock, sky-colored, but with a white blotch and reddish spots about the wings, and a long bunch of feathers on the crown." Many of the fruit-doves are strikingly beautiful, being adorned with vivid patches of crimson, blue, or yellow, on a pure green ground. Parrots are wonderfully varied, including the great black and the white

cockatoos; the lories, varied with crimson and purple, green, yellow, and black; while there are strange little crested green parrots no larger than our blue tit—the smallest of the parrot tribe, as the great black cockatoos are the largest. Kingfishers, too, are remarkably abundant, and include several of the fine raquet-tailed species, with plumage of silvery blue, and with white or crimson breasts. Many other groups of birds are also adorned with exceptionally gay colors; and a careful comparison with the birds of other countries shows that nowhere in the world is there so large a proportion of the whole number of species adorned with brilliant hues. Among insects the same thing occurs, though not in quite so marked a degree; yet the superior beauty of many groups of beetles over the corresponding groups in Borneo is very distinct; and the same is to some extent the case with the butterflies and moths.

Independently of the beauty and singularity, the great number of species of birds inhabiting New Guinea is very remarkable. Considering that there are no resident collectors in the island, and that our knowledge is wholly derived from travelers who have spent a few weeks or months on the extreme northern or southern coasts only, leaving the great mass of the interior wholly unexplored, the number of land-birds already known (about four hundred species) is surprising. It is very much greater than the numbers inhabiting the whole of the West Indian Islands, or Madagascar, or the large, rich, and comparatively well-explored island of Borneo. Even Australia, so much more extensive and so varied in climate and vegetation, has only four hundred and eighty-five land-birds; and when we consider that the central mass of New Guinea, with its lofty mountain ranges and fine upland valleys, yet remains absolutely unexplored, it is not improbable that the birds of this wonderful island may be eventually found to be as numerous as those of its parent continent. We may therefore safely assert that in no part of the world has the naturalist such a certainty of making new and important discoveries as in the still unexplored regions of central New Guinea.

The peculiar race of mankind inhabiting this great island attracted the attention of the earliest voyagers, and the country was called New Guinea from the resemblance of its inhabitants to the negroes of Africa, removed from them by nearly one third the circumference of the globe. The early writers, however, term the people Papuas or Papuans, a Malay term given to them on account of their woolly hair, so different from the perfectly straight hair of almost all the other Eastern races. The Malay word "papuwah" or "puah-puah" means frizzled like wool; and the Malays still call these people "orang papuwah"—woolly-haired men, and the island itself "tana papuwah"—the land of the woolly-haired.

It is a very remarkable fact that woolly-haired people should be

found in two such widely separated areas, and, with very few exceptions, nowhere else in the world. In Africa they occupy the larger portion of the continent, extending over all the tropical and southern regions; while in the East they are found only in a group of islands of which New Guinea is the center, extending westward as far as Flores and eastward to the Feejees. There are also a few outlying groups of woolly-haired people, which are of great importance as indicating that this type once had a wider extension than now. In the Pacific we have the now extinct Tasmanians; and far to the east, in the midst of the brown Polynesians, we find the inhabitants of Penrhyn's Island and Mangaia, in about 158° west longitude, to be of the Melanesian or dark race. In the Philippines there is an aboriginal race of woolly-haired dwarfs—the Aëtas or Negritos; and a similar descriptive term may be applied to the Semangs of the Malay Peninsula, and to the natives of the Andaman Islands in the bay of Bengal. These various Eastern tribes differ among themselves quite as much as do those of Africa. Both agree, however, in being usually very dark-skinned, and examples may be found in which negroes and Papuans are in all respects very much alike. But this is exceptional, and there is almost always a characteristic difference which would cause most of the Eastern negroes to appear out of place on the continent of Africa. The woolly hair, however, combined with the dark skin and almost always with a dolichocephalic or long skull, so markedly distinguishes all these people from the rest of the inhabitants of the globe, that it is impossible not to look upon them as being really related to each other, and as representing an early variation if not the primitive type of mankind, which once spread widely over all the tropical portions of the eastern hemisphere. Successive incursions of the lighter-colored, smooth-haired races seem to have exterminated them in many of the areas they once inhabited, while in some widely scattered spots a few scanty remnants continue to exist. Two important groups, however, remain predominant in regions very far apart, but each well suited to their vigorous development. The negro of Africa has been made the servant of the more civilized races from the earliest periods of history, and is better known to us than any other uncivilized people; while the Papuan or Melanesian, inhabiting a group of tropical islands on the other side of the globe, still remains a mere shadowy name to the great majority of English readers. We proceed now to point out the chief physical and mental characteristics, habits, and customs of this interesting race as it exists in New Guinea, with occasional references to such modifications of it as occur in the other islands.

We now possess trustworthy descriptions of the Papuans as they exist at numerous localities scattered all round the extensive island they inhabit; and the substantial agreement of these descriptions renders it pretty certain that all belong to one race, exhibiting, it is true, considerable variations, and occasionally presenting undoubted

signs of intermixture with other races, but always showing a decided predominance of true Papuan characteristics. In stature they present a medium between the short Malays and tall Polynesians, the average height varying at different parts of the coast from five feet two to five feet eight inches. Some tribes in the interior are believed to be as dwarfish as the Negritos of the Philippines, while others are nearly equal to the tall Feejeeans, who are often considerably over six feet high. They are strong and muscular, but rather less finely formed than many of the Malayan and Polynesian tribes. Their color is usually a chocolate-brown, sometimes almost black, at others almost as light as some of the Malays. It is, however, by their features that they are best distinguished from all other races of men, and especially by the form and size of the nose. This is always large and long, usually arched as in the Jewish type, and, when well developed, with the extremity so lengthened as to hide the nostrils and overhang the upper lip. This peculiar characteristic is found more or less developed everywhere round the coast of New Guinea, so that almost every traveler speaks of the "Jewish features"—the "aquiline" or "arched" or "very prominent" noses—or makes use of other similar expressions, clearly showing that this is the typical Papuan feature, a fact which is further demonstrated by the unmistakable though exaggerated manner in which it is represented in all their images and carvings. The nose is also very thick and coarse, as is the case in almost all savage races; the alæ are very oblique, and the base is much depressed between the eyes, a character which reaches its maximum in the natives of New Caledonia and the New Hebrides, though the nose itself is with them somewhat shorter. The forehead is rather flat and retreating, the mouth large, and the lips full but not excessively thick; nor is there any marked prognathism. The combination of these peculiarities in various degrees produces faces which are sometimes ugly and savage-looking, while others have so much the character of the Jew or Arab as to be really handsome. Comparing Papuans with typical negroes of equatorial Africa we find a radical difference in the small flat nose and very prominent jaws of the latter. In the South African races this difference is less pronounced. The Bechuánas and Natal Caffres have less prognathism and a straighter, better-formed nose, but this organ is always shorter and less arched than in the Papuan. The Hottentots have often well-formed features and sometimes have a considerable resemblance to the less typical Melanesians. The greatest resemblance, however, is to be found between the Negritos of the Philippines—who have short flat noses and somewhat projecting jaws—and some of the dwarfish tribes of Central Africa.

The Papuan contrasts strongly with Malays and Polynesians in being hairy-bodied and tolerably well bearded, but still more so by the wonderfully luxuriant growth of the hair of the head, which forms a dense mop often projecting six or eight inches from the skull. It is crisp, glossy, and very elastic, and each separate hair naturally curls itself up

into a spiral of small diameter. The degree of twist and consequent woolliness of the hair seems to be dependent on its being oval or flattened instead of cylindrical. In the straight-haired races and in most Europeans the hair has a circular section, which becomes slightly oval where it is naturally curly; but in the negro and Papuan it is much flattened, and has besides irregular wavy margins, which seem to produce the strong spiral twist. Those who possess a large mop of hair are very proud of it, keeping it continually combed out with a kind of bamboo fork, and using a narrow wooden pillow on which to rest the nape of the neck, so as to preserve the hair from being squeezed out of shape. It was long thought that the hair of these people possessed a peculiar character in growing in separate small tufts scattered uniformly over the scalp; but more accurate examination shows that it grows evenly over the surface of the head, and that the tufted appearance probably arises from the tendency of the spirally twisted hairs to mat together in small, curly locks. The hair on the body and limbs, though very short, has the same appearance and a similar structure.

The dress of these people is very scanty, the men wearing the usual T-bandage of bark-cloth, but in some cases only a shell, or even going absolutely naked; while the women always wear some kind of girdle from which is suspended a small apron of bark or a fringe of leaves. As with most savages, ornament is more attended to than dress, and is more used by the men than by the women. They often pierce the sides of the nose, sticking in them pieces of bone, feathers, or tusks of the wild pig. The ears are also pierced, and either shell ear-rings are worn, or sticks ornamented with feathers are stuck through the lobes. Necklaces of teeth or shells are common, and heavy rings of white shell or plaited bands of grass or palm-leaf are worn on the arms. The hair of the men is always carefully attended to. It is combed with a kind of bamboo fork with four or five prongs, and this is usually kept stuck in it both for convenience and ornament. Some tribes cut and trim or plait the mop of hair into various helmet-like or other fantastic shapes, and all adorn it with combs, sticks, or feather ornaments. Suspended from the neck they often wear a small carved wooden figure with the Papuan features greatly exaggerated. As they freely part with these, they are probably mere ornaments or charms rather than idols or fetiches. Regular tattooing is unknown, except on the southeastern peninsula where there is an infusion of Polynesian blood, but most of the men have raised marks produced artificially. These generally consist of a few short parallel lines on the arms or breast, and are said to be formed by gashes made with a sharp stone or bamboo, and the subsequent application of fire to make the skin swell up and leave a prominent scar. Painting the body is not generally practiced, but some kind of stain producing a blue-black tinge has often been observed.—*Contemporary Review.*

EXPERIMENTS WITH LIVING HUMAN BEINGS.

By GEORGE M. BEARD, M. D.

II.

IN experimenting with living human beings, deception, whether voluntary or involuntary, can only be scientifically met by deception; it must be beaten with its own weapons. No experiment of this kind in which the results depend in any way on the honesty of the subjects experimented on can be of any value in science; and those who assume that, because the subjects of these experiments are members of great churches, and move in high society, they are therefore incapable of untruth, would do well to resign the task of investigations of this sort to those who are better endowed with the scientific sense. *Systematic, orderly, exhaustive deception*, on the part of the experimenter, as here suggested, will, in all cases, exclude both intended and unintended deception on the part of the subject or bystanders.

Sixth Source of Error: *Chance and coincidences.*—The subject of chance and coincidences seems never to have received the attention from men of science that its direct and practical bearings on experimental research and the principles of evidence would long ago have demanded. On the mathematical side the philosophy of chance has been investigated and discussed by various writers, and with not a little intelligence and skill; but with the effect also of misleading many amateur experimenters and reasoners, who have thereby been tempted to employ mathematical estimates in departments of science where they are sure to guide into error. No forms of error are so erroneous as those that have the appearance without the reality of mathematical precision. Of this sort are the blunders of those physiologists who, at various times and under various guises, have sought to solve physiological problems by experiments half built up on rigid mathematical calculations, the other half having no foundation at all; for the average non-expert observer is awed and overpowered by the very sight of figures, and assumes that an investigation into which addition, subtraction, and multiplication enter, must inevitably lead to precise and unerring results, forgetting that, as quantitative truth is of all forms of truth the most absolute and satisfying, so quantitative error is of all forms of error the most complete and illusory. Figures, to be of any value in science, must go all around the subject and thoroughly embrace it, else they fail to master it and become its possessor: for, while the truth is apparently shut in on one side, it is all the time stealthily escaping at the other. Thus it is that the most acute calculators, most logical reasoners, and most accurate observers as well, are so often cheated out of the truths to the search for which their lives are devoted; the instincts of the plow-boy often outstripping the wisdom of the philosopher.

Among this class of scientific blunders is the custom of applying the calculations of chances to experiments with living human beings. Thus in the now well-known mind-reading performances it was averred that by a mathematical calculation there would be but one chance in several hundred thousand of finding any object in a house or hall or assemblage; hence it was inferred that a new force, or manifestation of force, had been revealed to the world. The fallacies in this philosophy do not require a very long search; of the many objects in any house, or indeed in any public building, but a small minority would be accessible in any mind-reading test, and of these few only a limited number are of a sufficiently positive nature and description to be thought of by the subject of such experiments; then, in addition, are all the errors that come from intentional and unintentional assistance of audiences and by-standers.

Practically the only way to eliminate, in a scientific manner, the error of chance or coincidence in all experiments of that character, is by making comparative experiments in the same line, with all the sources of error closed except chance, and to repeat these a sufficient number of times to make an absolute domonstration. In this way it was shown that *mind-reading*, so called, was really *muscle-reading*. In these and in all studies of like character it is to be recognized that coincidences of the most extraordinary and astonishing nature are liable to occur at any instant, and that they are as likely to occur on the first trial as on the last of a long series. To determine whether any conjunction of events is simple coincidence, or the result of some new fact or law in science, is possible oftentimes only through a series of comparative experiments. In the researches which I made in muscle-reading it was shown over and over that by pure chance alone—every other element of error being excluded—the blindfold subject would, under certain conditions, find the object looked for in one case and sometimes in two cases out of twelve.

It would seem that the errors from chance and coincidence were the most patent of all the errors that complicate and confound scientific investigation, and so clear even to the unskilled and unthinking mind, that trained investigators would never be deluded by them. But in practice it vitiates the research and the philoscphizing of educated men, even more perhaps than any other of the six, excepting the involuntary action of mind on body which, as we have seen, has been the stone of stumbling for physiologists ever since physiology was introduced into science.

Hay-fever, for half a century and more, has supplied an unusual richness of material for false reasoning of a similar type. An English physician, a victim of this disorder, notices that he is worse as he crosses a field of grass, and concludes that at last he has found the one source of the mystery, and so gives the affection a misleading name which it can never lose; Helmholtz, a leader both in physics and physiology, puts the nasal secretions under the microscope, discovers some

unexpected infusoria that are killed by quinine, and announces to the world in one breath a theory of the disease and a specific for its cure, without apparently suspecting, what is now known, that the presence of infusoria might be a coincidence or effect and not a cause.

To all this it may be said that practically we do find out the true value of medicines and their objective action on the human body without systematically eliminating any of the six elements of error here pointed out. This is to be allowed ; but the admission of the fact requires also an explanation of the way in which these errors are in practice actually eliminated, although unintentionally and unsystematically, and I may say also, most unscientifically.

It is by an immense number of experiments or trials on a large variety of cases, at different times, by different observers, and under varying conditions, that medical science has been able, after centuries of doubt and struggle, to arrive at some few real scientific facts in regard to the action of medicines. If these six elements of error had, from the first, been everywhere recognized and comprehended and systematically guarded against, the process of finding the truth in this department might have been abridged by hundreds of years. The method by which, in practice, physicians learn the action of any new remedy, is to give it to a number of cases, and then to watch and report the results ; another physician repeats the experiments on a different set of cases ; he also notes the results: and this process goes on perhaps for years, until in lapse of time the profession, without being able to give precise and convincing reasons for their faith, slowly and instinctively settles down to the persuasion that the effects claimed for the remedy are genuine, and act accordingly.

In many instances they are right in this conclusion ; but how awkwardly and in what a roundabout way, and through what useless and wearying toil, have they, in doubt and distrust and suspicion, finally reached that goal ! All the trials with the remedy, from beginning to end, have been impaired in scientific value by some one or all of the six elements of error ; but through the immensity and variety of the experiments, extending through a long period, these errors have been *unconsciously* and *unwittingly* eliminated, so that only the solid fact is left. This unconscious elimination or rather leaving behind of errors, after the analogy of the formation of the universe according to the nebular hypothesis, takes place in this manner: In the first hundred cases treated there will be perhaps one or two, or more, who have no faith in and no expectation from it, good or bad ; these few obtain the real objective effects of the remedy, while all the others deceive, more or less, themselves and their physician. In subsequent experiments by other observers, some of whom perhaps are less hopeful than the original investigator, the same unconscious and irregular elimination takes place, until the objective power of the remedy may for all practical needs be regarded as established. Such is the history and philosophy of medical experi-

mentation in all ages and with all schools of medicine I claim that by the rigid following out of the principles here taught it will be possible for even the humblest member of the profession to take any new remedy, and, if a sufficient number of cases be provided, to accurately determine some points at least of its therapeutic value, if it really possesses any that are capable of being demonstrated to the senses or reason of man. It is the unconscious or unformulated apprehension of these errors in the working up of remedies that causes so many of the profession to take at certain periods of their lives the extreme and unscientific view that all medication is a mistake—that drugs have no power outside of the mind of the one who takes them—and consequently, and logically, to trust only to the forces of nature and hygiene.

In relation to this branch of our theme, it is worthy of note that there are certain modes of treating disease which from the very nature and manner of their employment can not be experimented with in a truly scientific way; it is impossible to use them so as to deceive the patient on whom they are used; of necessity, therefore, they must be developed by the process of successive eliminations already described. Among the medical procedures of this class are hydro-therapeutics or hydropathy, electro-therapeutics, and massage, or systematized rubbing, kneading, and manipulation; none of these remedial operations can be used without the patient's knowledge; none of them can be used in a different way from what the patient supposes they are being used; they are open, in clear sight, and affect the various senses so strikingly that satisfactory deception is impossible; patients know when they are being galvanized or faradized; they know when they are washed or showered; they know when they are rubbed and kneaded; no art or device of the physician can avail to so deceive them as to absolutely eliminate the error that comes from the hope or fear or expectation of what the treatment is to accomplish. The practical value of these methods of treatment—and they are all of undoubted value—could only be ascertained, as it has been ascertained, by the immense variety of the experiments that have been made with them, wherein through the process of time the six sources of error have been little by little eliminated.

In all new remedies and systems of treatment the aim of the scientific physician should be to make the deception so thorough that whatever effects are obtained must be known positively to be the objective action of the treatment or of nature. The criticism which I make on Burq, Charcot, and others, who have recently experimented with the action of metals of different kinds on the anæsthesia of hysterical patients, is that they left the question open when, by a systematic, orderly, and thorough provision against these six sources of error, they had it in their power, with the vast material at their command, to have absolutely closed it; if they could not determine with certainty whether the temporary disappearance of the anæsthesia on the application of

plates of copper or silver or gold was the result of feeble electrical currents excited, or of simple mechanical pressure, or of absorption, they could surely have answered, to the satisfaction of scientific men, the question whether it was to be explained subjectively or objectively; but this, through want of appreciation of the sources of error, or from want of a formula to guide them in their elimination, they failed to do. Even though it should be proved, as it may be, that some of these phenomena observed by Burq, and Charcot, and Westphal are objective, and independent of the expectation of the persons operated on, the validity of this criticism is thereby not at all affected. To attempt to build up a practice of metal-therapeutics on the basis of metalloscopy as that claim now stands, is like putting up a house before we are sure of our foundations. The first question to decide is whether metal-therapeutics is or is not really mental-therapeutics.

In the illustrations for this essay I have chosen, by preference, the experiments of scientific men of skill, honor, and distinction, and for the same reason that Blair, in his work on rhetoric, refers, for examples of incorrectness, inelegance, and carelessness of style, only to the writings of the greatest masters of style in the language: if these things be done in the green trees, what shall be done in those that are utterly dry? The average scientist, the every-day physician, the followers, the gleaners and popularizers of knowledge, are expected to blunder and teach but half truths, if not positive error; but if all those who should be our experts fail us, where can we look for clear ideas? It is no overplus of enthusiasm, no fancy of rhetoric, to say that if these six sources of error and the true methods of providing for them had been mastered half a century ago, the history of scientific experimenting during that time would have been radically different from what it now is.

On this subject no nation can throw stones at another; in all the great centers of modern civilization the strongest leaders of science and scientific thought have been and are constantly demonstrating their non-expertness in the art of experimenting with living human beings; the history of science, or the demonstrably true, and the history of delusions, or the demonstrably false, run in the same channels; but in the minds of the French there appears to be some psychological peculiarity that, while it urges them to undertake, at the same time unfits them to succeed in researches of this character, their very genius for science, as it relates to inanimate nature and the lower forms of life, predisposing them to all error when dealing with living human creatures; hence the paradox of history that France is at once the home of science and the home of delusions. Now, for almost a century, the ablest philosophers and experimenters of France have been wrestling with the problem how to experiment with living human beings; from the first committee of the French Academy on mesmerism, through Perkinism and Burqism, down to the very latest bulletin of Charcot on metalloscopy, it is one uniform, unbroken record of per-

severing non-expertness and failure : Science constantly baffled, beaten, utterly overthrown, yet as often returning to the hopeless contest, where delusions always compel a drawn battle, if they do not positively win ; experiments without number that have the form of precision without its substance ; all truth, or even the suggestions of truth, submerged in vast floods of error ; the faith that belongs to religion and emotion carried into the realm of science and intellect ; all along the line of strong endeavor an obvious want not only of the philosophy but even of the instinct of seeking truth from living human beings—in the whole history of folly one shall not find a more instructive chapter than this ; were there no other proof of the limitations of the human brain, sufficient could be found in this fruitless searching after truth on the part of the most intellectual leaders, of the most intellectual of nations, in the most intellectual era of the world. Not only during the past year, in the hospital of Salpêtrière, but, by recurring intervals, during the past century, the best science of France has been on its knees before hysterical women, and there it must remain until it has mastered the true philosophy of trance and the involuntary life, and learned by heart the sources of error.

The time must come when it shall be well understood that experiments with living human beings, in which the elements of error are unrecognized, are not only unscientific but are a satire on science ; bearing the same relation to the true method of investigation in this special department of physiology that the dreams of the mediæval sages sustained to the general philosophy of induction. The philosophy of the future will be that the laws of nature are not to be put on the market, and can not be bid off at auction, and that the long-standing and unaccepted financial prize of the French Academy for the one who should prove to be endowed with clairvoyant or mind-reading power is as unscientific and as puerile as to attempt the bribery of the law of the conservation of force, or to hire the sun to rise in the west instead of the east.

During the past few years it has been my destiny to have been frequently requested to carry out or to plan for others various experimental researches with living human beings ; these requests have sometimes come from professional and scientific men who, in all dealings with inanimate objects, are amply competent, both by instinct and by reflection, to guard against all illusions and deceptions. It is my hope and belief that this formal attempt—ill perfected as it may be—will so reduce this subject to a science as to bring it within the power of all physiologists to plan and to complete all such experiments for themselves, with ample confidence that the results will invariably be in harmony with the truth. The above analysis, in spite of its necessary condensation, will, it is hoped, make clear even to those who do not follow all its details, that in this, as in every other realm of knowledge and acquirement, success need not be the result of any special acuteness, or

cunning, or wisdom, but can be made the possession of any sober and well-trained mind that has a sufficient endowment of the scientific sense to recognize and submit to the inevitableness of law in all mental as in all physical phenomena, and to subordinate, even in scientific research, all feeling and emotion to intellect and reason.

The relation of this subject to delusions is also of much interest, both psychological and practical; during the present century especially the prevailing follies of civilization have received an unusual and unprecedented dignity and strength from the non-expert experiments of scientific men with living human beings. It is a part of the inconsistency of ignorance, and one of the effects of long breathing the atmosphere of superstition, that the apostles of the demonstrably false, while they uniformly dread and oppose the advance of their natural enemy, organized knowledge, yet pray for and welcome all mistakes of scientific men, either in experiment or philosophy, as so much addition to their capital; the weapons with which delusionists of every name prefer to fight their battles are forged in scientific armories; trace any one of the rank and overrunning superstitions of our day to its utmost radicle, and it will surely lead to sources where we are wont to look for light and truth —to some great discovery which our chemists, our naturalists, our astronomers, of fair and noble fame, have evolved, or are believed to have evolved, out of experiments that they have made, or tried to make, with living human beings; to the laboratory of some physiologist even, who forgets that the chief fact in human life is the involuntary life; to some logician and philosopher, who has yet to learn that the habit of trusting the senses, though endorsed and inculcated in all the universities of the world, is the source of half the ignorance and not a little of the suffering of mankind.

SHALL WE ADOPT THE METRIC SYSTEM?

DURING the second session of the Forty-fifth Congress, a great amount of evidence bearing on the question whether or not it would be wise to introduce the metric system into the United States was brought forward. This evidence is given in reports, etc., from the heads of the various executive departments, and the most important bureaus of the Government, and it is likely to remain buried in the vast mass of fugitive public documents known only by the "printer's number."

The editor has been at some pains to collect the scattered pieces and reports, and to put them into a continuous if not a connected form, with the object of making them available for reference in future. This it seems amply worth while to do for various reasons; chiefly because

these contributions to the solution of the really important question at the head of this article have a unique and special value. They have been written by officers high in position in the Government and entirely free from prejudice. Their recommendations were not influenced by any considerations as to their personal convenience, and their judgments were based on the actual operations of their several departments. It is somewhat singular, in examining their reports in detail, to find that there is so little repetition. For these reasons it appears that no such important additions to the literature of this subject have been made for many years. In what follows, brevity has been studied, and omissions have been freely made whenever possible, the object being to present only the most important arguments. The bills introduced into Congress are first given, and then follow the detailed reports of the heads of executive departments. No attempt has been made to answer the important questions considered, that having been left to the reader.

Mr. Muldrow introduced on November 3, 1877, a bill "to promote the establishment of the metric system of coinage in the gold coins of the United States of America.

"*Whereas*, The metric system of coinage, based on the gramme as the unit of weight, is now almost universally acknowledged to be the best; and—

"*Whereas*, The gold coinage of the United States can be brought into exact conformity with the metric system by a change amounting to less than one third of one per centum: therefore—

"*Be it enacted*, etc., That the gold hereafter coined by the United States shall contain, for each dollar of denominational value, one and one half gramme of pure gold, and shall weigh, for each dollar, one and two thirds gramme, the proportion of alloy to the entire weight being thus kept as one to ten.

"SECTION 2. That such coins shall be legal tenders in payments arising from contracts made at any time after the 4th day of July, 1878.

"SEC. 3. That such coins shall have stamped upon them, in addition to other devices, their weight in grammes, and the inscription, 'nine tenths fine.'"

Mr. Maish introduced on January 25, 1878, a bill "to establish the metric system in the post-offices and custom-houses of the United States.

"*Be it enacted*, etc., That on and after January 1, 1879, for all postal purposes, fifteen grammes shall be substituted for half an ounce, and so on in progression.

"SEC. 2. That on or before January 1, 1879, the Postmaster-General shall furnish all post-offices with postal balances denominated in grammes of the metric system, at an expense," etc., etc.

"SEC. 3. That on and after January 1, 1880, the metric system of weights and measures, as legalized in section 3,569 of the Revised Stat-

utes shall be *obligatory* in the assessment of duties on imported commodities in the custom-houses of the United States."

Mr. Stephens introduced, January 29, 1878, a bill "to enable importers to use the metric weights and measures."

"*Be it enacted*, etc., That the *ad quantum* duties upon all articles imported from foreign countries which are invoiced according to the weights and measures of the metric system shall be levied, collected, and paid at rates appropriate to the weights and measures of said system, that is to say:

"The rate per gramme shall be," etc. . . .

"The rate per kilogramme shall be," etc. . . .

"SECTION 2. That the quantity of weight, gauge, or measure stated in the return of any weigher, gauger, or measurer employed in the service of the customs revenue may be stated in metric denominations," etc., etc.

Mr. Stephens introduced, March 29, 1878, a bill "to promote the general use of the metric system."

"*Whereas*, The metric system of weights and measures has made little progress in actual use, notwithstanding its great merits and its authorization by law, by virtue of the act of Congress of July 27, 1876; and—

"*Whereas*, It is believed to be capable of simplification, so as to remove many impediments to its general use, yet retain its valuable features, and so to promote the great and desirable reform contemplated by the foregoing act: therefore—

"*Be it enacted*, etc., That the use of the modified metric system, set forth in the following tables marked A, be, and is hereby, authorized; the values of the metric units, so far as they are retained, remaining unchanged, and the continued use of any system now permitted by law not being prohibited, the true intent and meaning of this act being not to enforce any particular system, but to provide for the public convenience by adaptation to its circumstances and exigencies.

"SECTION 2. The metric system being capable of indefinite expansion to suit the ever-enlarging uses of mankind in business and science, the accompanying scale of units, names, and values is provided, marked B, on the scale of ten and its powers, and the use of all and any of them is hereby permitted and authorized.

A.—METRIC TABLES.

MEASURES OF LENGTH.

100 hairs make a nail.
100 nails make a metre.
1,000 metres make a kile.

MEASURES OF SURFACE.

10,000 square metres make a great acre.

MEASURES OF BULK AND CAPACITY.

100 drops make a spoon.
100 spoons make a quart.
100 quarts make a cast.

MEASURES OF WEIGHT.

100 seeds make a corn.
100 corns make a nut.
100 nuts make a bi-pound or bip.
1,000 bips make a ton.

B.—TABLE OF METRIC UNITS.

MEASURES OF LENGTH.

Ratio to next unit.	Metric name.	New name.	Value in English measure.
100,000..	.....	Atom unit.....	Inch.....0·00000000039
10..	.....	Heat wave.....	Inch.....0·00003937
10..	.....	Spider's web.....	Inch.....0·0003937
10..	.....	Hair.....	Inch.....0·003937
10..	Millimetre...	Pin.....	Inch.....0·03937
10..	Centimetre...	Nail.....	Inch.....0·3937
10..	Decimetre...	Hand.....	Inches.....3·937
10..	Metre.....	Metre.....	Inches.....39·37
10..	Decametre...	Half-chain	Feet.....32·809
10..	Hectometre..	Bow-shot.....	Yards.....109·363
10..	Kilometre...	Kilo.....	Mile .....0·62138
1,000..	Myriametre..	Bi-league.....	Miles.....6·2138
10,000..	.....	Earth quadrant.....	Miles.....6,213·8
.....	.....	Orbit unit.....	Miles.62,138,200·

MEASURES OF SURFACE.

Ratio to next unit.	Metric name.	New name.	Value in English measure.
100.....	Centare.....	Square metre.....	Square yards.....1·196
100.....	Are.....	Square half-chain.....	.....
100.....	Hectare.....	Great acre.....	Acres.....2·47114
.....	.....	Square kilo.....	.....

MEASURES OF BULK AND CAPACITY.

Ratio to next unit.	Metric name.	New name.	Value in English measure.
10.....	.....	Drop, $\frac{1}{1000}$ cubic inch.....	Cubic inch..... 0·0061
10.....	Millilitre....	Die = Nail cube, $\frac{1}{100}$ cubic inch.	Cubic inch..... 0·0610
10.....	Centilitre....	Spoon, $\frac{6}{10}$ cubic inch..... ..	Cubic inch..... 0·6102
10.....	Decilitre....	Wineglass.....	Cubic inch..... 6·102378
10.....	Litre.....	Quart = hand cube.....	Cubic inch.....61·023378
10.....	Decalitre....	Pail.....	Pecks..... 1·135
10.....	Hectolitre or decistere..	Cask.....	Wine-gallons.....26·418635
.....	Kilolitre or stere.....	Metre cube.....	Cubic feet.....35·31658 Or, bushels.....28·3742

WEIGHT.

Ratio to next unit.	Metric name.	New name.	Value in English measure.
1,000....	.....	Gas unit, $\frac{1}{70000}$ grain	Grain..... 0·000015
10....	Milligramme.	Seed = pin cube, $\frac{1}{70}$ grain	Grain..... 0·0154
10....	Centigramme	.....	Grain..... 0·1543
10....	Decigramme.	Corn = drop, 1½ grain.....	Grains ..... 1·5432
10....	Gramme	Die = nail cube.....	Grains .....15·43235
10....	Decagramme.	Nut, 3½ ounces.....	Ounces..... 3·5276
10....	Hectogramme	.....	.....
10....	Kilogramme..	Bip = hand cube, 2⅛ pounds...	Pounds ..... 2·2046
10....	Myriagramme	.....	.....
10....	Quintal	.....	.....
.....	Millier or tonneau.....	Ton.....	Pounds.....2,204·62125

This system is understood to be the invention of Mr. SAMUEL BARNETT, of Washington, Georgia.

It is believed that no other bills were introduced in relation to the metric system. It is perhaps worth while to quote a bill "proposing a reward for a new foot-measure," as a sample of what may be laid before Congress:

"*Be it enacted*, etc., etc., That the Congress of the United States of America will vote an appropriation, the same as a reward, to be paid the American citizen who shall produce a new foot-measure which shall divulge, in it, the truth of the meeting of parallel lines in exceeding great length."

A resolution of the House of Representatives (November 6, 1877) provided "that the heads of the executive departments be, and they are hereby, requested to report to this House, at as early a date as practicable, what objections, if any, there are to making obligatory in all governmental transactions the metrical system of weights and measures whose use has been authorized in the United States by act of Congress; and also how long a preliminary notice should be given before such obligatory use can be introduced without detriment to the public service; and that they are also requested to state what objections there are, if any, to making the metrical system obligatory in all transactions between individuals, and what is the earliest date that can be set for the obligatory use of the metrical system throughout the United States."

This resolution addressed directly the officers best qualified to judge of the questions involved, and their answers are given below, abridged when possible.

The Secretary of State reports: 1. That the obligatory use of the metrical system, so far as the operations of the Department of State are concerned, and especially its consular and commercial relations with foreign governments, while of convenience and utility with respect to those countries which have already adopted the metrical system to the exclusion of all others, would be of no benefit with regard to those

countries which have not so adopted it, and would introduce detrimental confusion, in particular in its commercial relations with Great Britain and other countries where the system of weights and measures is the same as that of the United States, with which countries the bulk of our foreign commerce is at present carried on.

2. That should the obligatory use of the metrical system in governmental transactions be enacted, two years' preliminary notice of the change would suffice to bring the system into harmonious and uniform use in this department and its dependencies abroad.

3. That the Department of State does not seem to the Secretary of State to be in a position to express an authoritative opinion as to the obligatory adoption of the metrical system in all transactions between individuals, inasmuch as its relations directly with the people of the United States are not of a character to be either beneficially or injuriously affected by the suggested change. He ventures to remark, however, that even in those countries, like France, where the system has been obligatory beyond the memory of the present generation, the tradition of the old system clings among the people and defies complete eradication; and that in other countries, like Spain, where the metrical system is adopted in governmental transactions and legalized for those of individuals, the innovation is practically disregarded by the people and but partially conformed to by the Government, which is compelled to recognize the validity of the old standards, in which the continuing transactions of the nation, such as the registration of landed property, the assessment of industrial taxation, etc., are still, and must be of necessity for many years, recorded. While recognizing that the proposed measure is one mainly affecting the people, and therefore properly to be legislated upon by the popular representatives, the Department of State, being called upon for a specific opinion on the subject, is, on the whole, indisposed to recommend the obligatory use of the metrical system in all transactions between individuals.

4. That should its obligatory use as between individuals be enacted, a period of not less than five years should be allowed to elapse before the act takes effect; and that even then provision should be made for the recognition of the legal validity of transactions according to the present lawful systems of weights and measures.

The Secretary of the Navy reports: "If it were desired to make the metrical system of weights and measures obligatory in all government transactions, the Navy Department perceives no objection to it except in so far as it regards the soundings given on charts. If it were applied to these, it would probably involve a total loss of all charts and chart-plates now in use. The alteration of these would give them no increased value; and as long as English charts remain in fathoms and feet it would be in fact prejudicial, and prevent that free use and interchange of charts which seem essential to navigators.

"So far as this department is concerned, no longer notice would be

necessary than was sufficient to furnish the standard weights and measures adopted for government use.

"Respecting the last inquiry submitted by the resolution, 'What objections there are, if any, to making the metrical system obligatory in all transactions between individuals, and what is the earliest date that can be set for the obligatory use of the metrical system throughout the United States?' the department is unable to give a definite answer, inasmuch as it is not informed as to the present intention of the English-speaking peoples in regard to the adoption of the proposed change. However desirable or advantageous in theory the change might seem, if adopted by us and not by the other peoples speaking the English language, it would seem probable that a mutual disadvantage would exist growing out of diverse weights and measures.

"It may be assumed that a more general intercourse will exist between peoples speaking a common language than between peoples who speak different languages. And looking at the present geographical extent of the countries wherein the English language is used, and the importance of their commercial intercourse, and also its future importance, as compared with any other of the spoken languages, at a period not at all remote, if regarded historically, it would seem to be of doubtful expediency to separate ourselves from what is now common in weights and measures with other people who speak our language, and with whom it is desirable to increase rather than diminish our commercial intercourse. Experience would indicate that we should hold ourselves in accord with them, rather than adopt other standards, however theoretically advantageous, for it will be impossible to escape many practical disadvantages if our standards vary from theirs, so long as our intercourse shall continue."

The Postmaster-General reports as follows: "In reply to the request contained in the resolution of the House of Representatives, I have to say that the only objections to making the use of the metric system of weights and measures obligatory throughout the domestic postal service, which occur to me as having been made or as likely to be made, are two: one based on the expense incident to the change of systems, and the other based on an apprehension that the practical workings of a new system will fail to give satisfaction, owing to the lack of knowledge of the metric system and experience in its use and application on the part of postmasters and of the public at large.

"In order to ascertain the probable force of the first objection, I have caused an estimate to be made of the probable number, grade, and cost of the balances and scales of the metric system which should be provided to take the place of those now in use in case a change is ordered. The estimate is that the sum of $124,788 would be called for as an immediate outlay to provide for the change.

"In regard to the second objection, it is not to be denied that the metric system of weights and measures corresponds in principle with

the decimal system long in use in the United States for coinage and money valuations, and that presumptively no greater inherent difficulty is likely to be encountered in the application of the decimal system to our weights and measures in the domestic postal service than was met in the change from the English system of coinage and money valuations to the present one. The latter is certainly the simpler one, and has for some time past been in use for the foreign mail service of this department. The objection, then, is in my opinion founded on an apprehension that mistakes, and consequently resulting annoyances, and possibly losses, would occur in the practical application, and not on any well-grounded objection to the principle of the metric system. This apprehension would, I believe, be greatly lessened, if not altogether abated, were sufficient time given for familiarizing postmasters and the general public with the practical workings of the new system before discontinuing the use of the old one.

"I have only the same means that any other citizen has of forming a judgment in regard to the last inquiry made in the resolution of the House, and I therefore deem it proper not to attempt to make an answer to it in this connection."

The Secretary of War replies by forwarding the reports of his chiefs of bureaus.

The Inspector-General reports: "Although I have had no practical experience in the use of the metrical system of weights and measures, yet, in my judgment, the compulsory change from the present system would be inexpedient, as involving a large outlay of money without adequate comparative results."

The Quartermaster-General reports: "In reply to the reference of the resolution of the House of Representatives of the 6th instant, in regard to the objections which may exist to making the use of the metric system of weights and measures obligatory, first, in all government transactions, and, second, in all transactions between individuals, and the length of preliminary notice desirable before such metric law goes into operation in the United States, I have the honor to say that if the law makes the use of the metric system obligatory in all government transactions it can be adopted by officers of the Quartermaster's Department as soon as notified by general orders.

"Such an order can be distributed to every military post within the space of one month from the time of its publication, and, if the telegraph be used, within one week.

"The objections thereto which at once occur to me are:

"1. It will very considerably increase the labor of computation, for, in practice, all sellers to the United States will make their deliveries in accordance with the English measures now in general use, and the officers, using the ordinary scales for weight, and the yard, foot, and inch, and bushel, gallon, quart, and pint for measures, will first ascertain the quantities and sizes in the present weights and measures, and then, by

the use of tables to be distributed, will reduce them to metric quantities in their statement of their vouchers, receipts, and accounts, which will, it appears to me, be a perfectly useless labor.

"2. This reduction, involving additional calculations and transfers from one set of units to another, unfamiliar and much less convenient, will infallibly be the source of many mistakes, to the loss of the disbursing-officer of the Treasury, or of the person who sells supplies to the United States.

"3. It will be necessary, in order to make the operation of such a law really successful, to throw away all the hay-scales and other platform-scales whose beams are now divided according to the American standard units of weight, and all the rules and measures divided according to the yard, foot, and inch, and all the weights, pounds, ounces, or grains, of avoirdupois, troy, and apothecaries' weight, and to purchase, distribute, and substitute new scales and new weights according to the metric system. These changes will be expensive. The trouble and labor I do not speak of, as such labor will, in case of the passage of a law, simply be the duty of all officers and employees of the United States.

"4. If the metric system is made obligatory in government transactions and not in transactions between individuals, then continual confusion and misunderstanding will be caused by the use of one standard by the Government and another by the people. All packages are put up by merchants, manufacturers, and producers in accordance with the actual legal standards, pounds, ounces, grains, yards, feet, inches. The transactions of the United States, large as they are, are insignificant compared with those of private trade. Manufacturers and consumers, and the people, will not change their customs at the call of the officers of the United States.

"In regard to making the metric system obligatory in transactions between individuals:

"1. I do not believe that this is within the power of Congress. It will be looked upon by the people as an arbitrary and unjust interference with their private business and individual rights, and I do not think that they will submit to it. It will inflict, if it can be enforced, a great loss upon many, especially upon manufacturers and mechanics whose shops are filled with costly tools, standard gauges, dies, and machines, all constructed upon the basis of the foot and inch.

"Every geared lathe in the United States depends upon a screw of a certain number of threads to the inch, and all the screws it produces are gauged in pitch and diameter by the inch.

"The metre is not commensurate with the inch, foot, or yard; all reductions are approximate only. The law of July 27, 1866, makes the use of the metric system permissive, legal, but not obligatory, and establishes for the reduction of metres to inches, and the reverse, the ratio of one metre to thirty-nine and thirty-seven hundredths inches, which is not absolutely correct. To alter all this machinery, to change

all these machines, gauges, dies, screws, and other parts of engines, will be the work of years—will cost millions of dollars.

"The metric system is not a convenient one for common use. Its measures are not of convenient length. The yard, half the stature of a man, is of convenient length to handle, to use, to apply. It, and the goods measured by it, can be halved, quartered, subdivided into eighths, sixteenths, thirty-seconds, sixty-fourths, etc.; or it can be with equal facility divided into tenths, hundredths, thousandths. Half a metre is no dimension; half a centimetre is an unknown quantity; but half a yard, half a foot, half an inch, half a bushel, one fourth of a bushel, of a quart, of a pint, etc., are recognized. If half a litre, of a decilitre, or a quarter, eighth, or sixteenth of these quantities is provided for, then the metric decimal system is abandoned at once.

"In calculation the metric system applies admirably to money and accounts of money; but even here the Government has been obliged to abandon for the convenience of the people the true, strict, decimal system, and to coin half a dollar, half an eagle, the quarter of a dollar, etc.

"In the use of weights and measures, however, there are not so great advantages in the decimal system. The unit is too large, and the numbers produced and used in the calculations of the engineer are tedious to write and are beyond the limits of ready apprehension.

"The ciphers and figures 0·00000073 convey no idea to a mind trained in the English and American system, and yet such combinations are common in French works of science and mechanics.

"The true scientific natural basis of the metric system has been abandoned. The metre was intended and enacted to be the ten-millionth of the quadrant of the terrestrial meridian of Paris. In the progress of geodesy and science, it is ascertained that the standard metre bears no (exact) relation to that quadrant, and, though it is probably very nearly the ten-millionth of the quadrant of the meridian in which New York lies, it is not probable that it is the ten-millionth of either of the three other quadrants of that meridian, or of any quadrant of any other meridian.

"The fact is, that the metre is quite as arbitrary and unscientific a standard as the foot or yard. It is of less convenient length than either of them, and its compulsory adoption would derange the titles and records of every farm and of every city and village lot in the United States; would put every merchant, farmer, manufacturer, and mechanic to an unnecessary expense and trouble, and all, it seems to me, for the sake of indulging a fancy only, and a baseless fancy, of closet philosophers and mathematicians for a scientific basis of measures and weights which (as the metre is not a ten-millionth of the Paris quadrant, is not what it professes to be and was enacted to be) can not be found in the French metric system.

"1. The unit of length: The metre is 3·280890 + feet, or 39·37079 + inches.

"2. The unit of area: The are is 119·60332+ square yards.

"3. The unit of liquid measure: The litre is 0·26418635+ gallon, or 1·0567454+ quart, or 2·1134908+ pints.

"4. The unit of space: The stere is 1·308764+ cubic yard, or 35·386636+ cubic feet.

"5. The unit of weight is: The gramme = 15·43234874+ grains troy.

"6. The unit of roods is: The kilometre = 1,000 metres = 0·62138+ mile.

"7. The unit of land-measure for farms and city lots is: The hectare = 2·47114+ acres.

"8. The commercial unit of weight is: The kilogramme = 1,000 grammes = 2·20462125+ pounds avoirdupois.

"What will our farmers, citizens, merchants, tradesmen, and mechanics do with these figures? And will they submit to being obliged to reduce acres, feet, inches, pounds, and ounces by multiplying or dividing by the above figures?

"I think that to make the French metric system obligatory between individuals in this country will be an impolitic and arbitrary interference with the rights, interests, and habits and customs of the people."

The Surgeon-General reports: "In compliance with instructions from your office calling for reports as to objections to making the use of the metrical system of weights and measures obligatory in all government transactions, and also obligatory in all transactions between individuals, I have the honor to report as follows:

"1. As to the first of the questions submitted in the resolution, I feel constrained to express the opinion that the gravest inconveniences would immediately result from an attempt to render obligatory upon government officers only the use of a system of weights and measures whose units are so entirely different from those which have heretofore been, and would then continue to be, in general use among the people. I pass by the enormous difficulties which would result from compelling government officers to use a different unit for the *measures of length* from that used by the people. This would not only throw into confusion the whole system of land measurement as practiced in the United States, but would produce the most serious inconveniences from the resulting effort to use in all government works tools and machinery gauged by a different standard from those in common use. These and similar inconveniences, some of them of the most deplorable kind, would be felt so much more severely by other departments of the Government that the duty of representing the force of these objections may safely be left to them. I confine myself, therefore, in this report, to a brief statement of the disastrous inconveniences which would result to the medical department of the army from the measure in question. This measure would compel the substitution of the metric system of weights and measures in prescribing and dispensing medicines in the army for

the system of apothecaries' weights and measures at present in use by the medical profession of the United States.

"In all the medical and surgical works of any importance printed in the English language the doses are expressed in apothecaries' weights and measures. The immediate effect of compelling medical officers of the army to substitute the metrical weights and measures would be, to force them to make a series of arithmetical calculations every time they attempt to use the prescriptions or doses laid down in any medical work written in the English language. This thankless and unnecessary labor would waste much precious time, and an error might cost life. Moreover, the strength of the various medical tinctures and solutions in use in England and America has been so adjusted that the proper dose is expressed in even minims, drachms, or fluid ounces. Merely to substitute for these simple quantities the corresponding fractional numbers would be a silly waste of labor; and in order that a proper dose might be expressed in an even number of cubic centimetres, a revision of the Pharmacopœia would be necessary, and this would have to be followed by a corresponding revision of all the medical books in common use before the new Pharmacopœia could be conveniently used. In my opinion the best interests of sick officers and soldiers require that the medical staff of the army should, in all its operations, act in the most complete harmony with the medical profession of the United States, and I can not do otherwise than express my belief that the discordance in practice, which would be imposed by such a statute as is suggested, would be fraught with the most unfortunate consequences.

"2. As to the second question, while I admit that the enforced introduction of the metric system would produce less detriment to the public service if it were rendered obligatory upon the whole people than if its use were simply compelled in government transactions, I must express the opinion that great public inconvenience would result if at the present time its general use were rendered obligatory by the exercise of an arbitrary act of power. I leave to others to point out the disorders likely to result in the land measurements, the railroad interests, and the general machinery interests of the United States, in all of which the units at present employed are incommensurable with those of the metric system, so that the use of long decimal fractions in the most ordinary transactions would become imperatively necessary as the only road of escape from still greater evils. I confine myself merely to the question of the interests of the medical profession of the United States, and must express the opinion that it will be time enough when they have asked for it to impose upon that body a change which will put all their operations out of harmony with the similar proceedings of other English-speaking nations. For assuredly many of the inconveniences which would be felt by government officers, if compelled to use a system of weights and measures not used by the people, would be felt by the whole

people if they are compelled to use a system so materially different from that employed by other English-speaking people. These inconveniences would only be reduced to the minimum, if, by an international convention between the United States and Great Britain, a mutual agreement were entered into to bring the system simultaneously into use among all English-speaking people. Unless some such international arrangement can be effected, I think it would be wiser for the friends of the metric system to remain for the present content with the law which has legalized its use by those who may find it well adapted for their own particular work. If it possesses the great advantages claimed for it over the older system, its use being already authorized by law, it will gradually extend until it has crowded all others out of existence, and no further legislation than that already had will be necessary to secure ultimately its general introduction. If, however, its advantages are so far counterbalanced by its disadvantages, at some of which I have briefly hinted, that, its use having been legalized, the people will not employ it of their own accord, its enforced introduction would be a great public wrong."

The Commissary-General of Subsistence reports: "I have the honor to state in reply to the first branch of the inquiry covered by the resolution, that to make obligatory, in government transactions, the metrical or any other system of weights and measures not in use by the people, and consequently not familiar to or generally understood by them, would not only involve great confusion and great extra labor in making reductions from the system in use by the people to the system adopted for the Government, but I believe that the people would look with grave suspicion upon government transactions based on a system of weights and measures which they did not understand; and that to adopt a system exclusively for the Government would have a tendency to remove the Government further from the people, and weaken, if not nearly destroy, their confidence in the integrity of the officials and agents of the executive departments.

"To the second branch of the inquiry covered by the resolution, I would respectfully submit that I not only believe great detriment would ensue from the adoption of the metrical system exclusively for the use of the Government, but that it would be, also, inexpedient for the United States to make the system obligatory between individuals, unless in cooperation with Great Britain, with whom we are so intimately connected by language, literature, and commerce.

"The change to a new system of weights and measures, based upon units widely different from and incommensurable with those upon which the system now in use is based, must necessarily require a great effort, and should be preceded by a long period of preparation, say twenty years. Even with the most thorough preparation, the change, when made, will bring with it almost inextricable confusion and wellnigh intolerable inconvenience, however superior to the existing system the

metrical system may be by reason of its decimal character, its symmetry, and its consequent simplicity."

The Paymaster-General reports: "I believe that the eventual introduction into common use of the metrical system is highly desirable, and is fast becoming still more necessary in our intercourse with foreign nations, especially if it is destined, as seems likely, to pervade the world. The great objects attained by it will be, fixed standards, uniformity, and the extension of the decimal system, found so useful in our money standards.

"I am satisfied that it will be advisable to begin first with legislation making the metric system obligatory in certain (not in all) government transactions. In the collection of customs, in the postal system, and in fixing the rates of coinage, and in all international transactions, it should now be made obligatory from the 1st of July, 1879. I do not recommend its adoption in the land system, and in purchases for the army and navy, and for the Government, at so early a date.

"By this first proposed legislation, a stimulus would be given for the system being taught in all the schools. Thus in six years the rising generation would be initiated and accustomed to it. It would be time enough then for legislation making its use obligatory in all remaining government transactions.

"After a full trial of these measures the people might be prepared for its voluntary introduction in domestic transactions, and for legislation making it obligatory. But it is desirable that there should be no premature legislation of this last-named character, creating discontent and an unfortunate repeal of untimely laws enacted in advance of public sentiment. The preliminary measures referred to would prepare the public mind gradually for final legislation."

The Chief of Engineers reports: "The resolution presents two main inquiries: first, as to the adoption of the metric system in the government offices; and, secondly, as to its adoption in transactions between individuals.

"So far as the proposed change would affect the works carried on under charge of the officers of the Corps of Engineers, it need only be said that while any change in the ordinary and accepted standards must be an inconvenience, yet there is no other reason why the change should not be made, provided sufficient time is given for preparation. It is thought that the French metric standards should not be adopted, to the exclusion of the present standards, in this office within a less interval of time than five years after the passage of the act. This limit is fixed as the minimum, in order to allow for the proper careful manufacture, comparison, and distribution of standards, and their duplication in various forms for ordinary use, for the necessary changes in tables and formulæ, and more especially to allow a sufficient interval of time during which a practical familiarity with the new standards may be acquired, particularly by those with whom the business of the engineer

department is transacted and who are not in the public service, as well as by those not in the public service who use the maps, charts, etc., of the department.

"In regard to the compulsory use of the metric standards in the transactions of individuals, certain additional considerations present themselves. It is to be borne in mind that there is nothing in the proposed change which will in any way favorably affect the usual course of private business in this country, and that the demand for a change from the present system does not come from business men, but is made in furtherance of a project designed for the general public good in international intercourse. There is no pressing necessity for immediate change, and it would undoubtedly be better, if the change should be made, to make it by concerted, simultaneous action on the part of all English-speaking people.

"The relations of trade between this country and Great Britain are such that the adoption of new standards of weight and measure by the one without the concurrent action of the other is extremely undesirable.

"As to the general question whether it is desirable to adopt a decimal system of weights and measures, there will probably be but little difference of opinion, since its adoption will to some extent simplify existing tables, and tend to establish a uniformity of practice throughout the world. As an actual practical fact, its adoption is a matter of no immediate importance, and certainly should not be made obligatory upon individuals before it has become generally understood by being adopted in the government service and taught in all public schools.

"The French decimal metric system has been adopted and made compulsory in France, Belgium, Holland, Greece, Italy, Spain, Portugal, Germany, Colombia, Venezuela, Ecuador, Brazil, Peru, Chili, and the Argentine Confederation and Uruguay.

"Great Britain and the United States have legalized the system, but have not made it compulsory. Switzerland, Sweden, Denmark, and Austria use partial decimal systems, but with different units of length and of measure."

PSYCHOMETRIC FACTS.

By FRANCIS GALTON, F. R. S.

THERE lies before every man by day and by night, at home and abroad, an immense field for curious investigations in the operations of his own mind.

No one can have a just idea, before he has carefully experimented upon himself, of the crowd of unheeded half-thoughts and faint imagery that flits through his brain, and of the influence they exert upon his

conscious life. I will describe a few of the results of my own self-examination in respect to associated ideas.

It was after many minor trials that one afternoon I felt myself in a humor for the peculiar and somewhat severe mental effort that was required to carry through a sufficiently prolonged experiment as follows: I occupied myself during a walk from the Athenæum Club, along Pall Mall to St. James's Street, a distance of some 450 yards, in keeping a half-glance on what went on in my mind, as I looked with intent scrutiny at the successive objects that caught my eye. The instant each new idea arose, it was absolutely dismissed, and another was allowed to occupy its place. I never permitted my mind to ramble into any by-paths, but strictly limited its work to the formation of nascent ideas in association with the several objects that I saw. The ideas were, therefore, too fleeting to leave more than vague impressions in my memory. Nevertheless, I retained enough of what had taken place to be amazed at the amount of work my brain had performed. I was aware that my mind had traveled, during that brief walk, in the most discursive manner throughout the experiences of my whole life; that it had entered as an habitual guest into numberless localities that it had certainly never visited under the light of full consciousness for many years; and, in short, I inferred that my every-day brain-work was incomparably more active, and that my ideas traveled far wider afield, than I had previously any distinct conception of.

My desire became intensely stimulated to try further experiments, and, as a first commencement of them, to repeat the walk under similar circumstances. I purposely allowed a few days to elapse before doing so, during which I resolutely refused to allow my thoughts to revert to what had taken place, in order that I might undergo the repetition of the trial with as fresh a mind as possible. Again I took the walk, and again I was aware of the vast number of extremely faint thoughts that had arisen; but I was surprised and somewhat humiliated to find that a large proportion of them were identical with those that had occurred on the previous occasion. I was satisfied that their recurrence had in only a very few cases been due to mere recollection. They seemed for the most part to be founded on associations so long and firmly established, that their recurrence might be expected in a future trial, when these past experiments should have wholly disappeared from the memory.

It now became my object to seize upon these fleeting ideas before they had wholly escaped, to record and analyze them, and so to obtain a definite knowledge of their character and of the frequency of their recurrence, and such other collateral information as the experiments might afford.

The plan I adopted was to suddenly display a printed word, to allow about a couple of ideas to successively present themselves, and then, by a violent mental revulsion and sudden awakening of attention, to

seize upon those ideas before they had faded, and to record them exactly as they were at the moment when they were surprised and grappled with. It was an attempt like that of Menelaus, in the "Odyssey," to constrain the elusive form of Proteus. The experiment admits of being conducted with perfect fairness. The mind can be brought into a quiescent state, blank, but intent; the word can be displayed without disturbing that state; the ideas will then present themselves naturally, and the sudden revulsion follows almost automatically. Though I say it is perfectly possible to do all this, I must in fairness add that it is the most fatiguing and distasteful mental experience that I have ever undergone. Its irksomeness arises from several independent causes. The chief of these is the endeavor to vivify an impression that is only just felt, and to drag it out from obscurity into the full light of consciousness. The exertion is akin to that of trying to recall a name that just, and only just, escapes us; it sometimes seems as though the brain would break down if the effort were persevered in, and there is a sense of immense relief when we are content to abandon the search, and to await the chance of the name occurring to us of its own accord through some accidental association. Additional exertion and much resolution are required, in carrying on the experiments, to maintain the form of the ideas strictly unaltered while they are vivified, as they have a strong tendency to a rapid growth, both in definition and completeness.

It is important, in this as in all similar cases, to describe in detail the way in which the experiments were conducted. I procured a short vocabulary of words, and laid it open by my side. I then put a book upon it in such a way that it did not cover the word that was about to be displayed, though its edge hid it from my view when I sat a little backward in my chair. By leaning forward the word came into sight. I also took many petty precautions, not worth describing, to prevent any other object besides the word catching my attention and distracting the thoughts. Before I began the experiment, I put myself into an easy position, with a pen in my right hand resting on a memorandum-book, and with a watch that marked quarter seconds in my left hand, which was started by pressing on a stop, and continued going until the pressure was released. This was a little contrivance of my own appended to one of Benson's common chronographs. When I felt myself perfectly in repose, with my mind blank, but intent, I gently leaned forward and read the word, simultaneously pressing the stop of the watch. Then I allowed about a couple of ideas to present themselves, and immediately afterward released the stop and gave my utmost power of attention to appreciate with accuracy what had taken place, and this I recorded at once. Lastly, I wrote down at leisure the word that had been displayed, and the time shown by the chronograph to have been occupied by the experiment.

The number of words used in the experiments I am about to de-

scribe is seventy-five. I had intended it to be one hundred for the convenience of writing down percentages; but my original list became reduced by mislaying papers and other misadventures not necessary to explain. The result was, that I procured a list of seventy-five words, which had been gone through as described, on four separate occasions, at intervals of about a month. Every precaution was used to prevent the recollection of what had taken place before from exercising any notable influence. It was not difficult to succeed in doing so, because the method of proceeding is permeated by the principle of completely discharging from the mind the topics on which it had previously been engaged.

I am particularly anxious that the fairness of the experiments should be subject to no undue doubt, and will therefore add yet a few more words about it. It may be thought an impossible feat to keep the mind as free and placid as I have described during the first part of the experiment, when the great change of its attitude in the second part was imminent. Nevertheless, it was quite practicable to do so. The preoccupation of my thoughts was confined to a very easy task, viz., to govern the duration of the experiment. We have abundant evidence of the facility of this sort of operation. We all of us have frequent occasion to enter heart and soul into some matter of business or earnest thought, knowing that we have but perhaps five minutes' leisure to attend to it, and that we must then break off on account of some other engagement. Nay, we even go to sleep, intending to awake earlier or later than usual, and we do it. In the present case, after about two ideas had successfully arisen, I succeeded, almost as a matter of routine, in lifting my finger from the spring-stop, and that little act was perhaps of some assistance in helping me to rouse my consciousness with the sudden start that I desired.

Now for the results. I found, after displaying each word, that some little time elapsed before I took it in, chiefly because the process had been performed so quietly. If the word had been flashed upon a dark background in large and brilliant letters, or if some one had spoken it in an abrupt, incisive tone, I am sure that period would have been considerably shortened. Again, whenever we read a single substantive without any context or qualifying adjective, its meaning is too general to admit of our forming quickly any appropriate conception of it. We have no practice in doing so in ordinary reading or conversation, where we deal with phrases in block, and not with separate words. Hence the working of the mind is far less rapid in the experiments I am describing than on common occasions, but not much less than it was in my walk along Pall Mall.

I found the average interval that elapsed between displaying the word, and the formation of two successive ideas associated with it, to be a little less than two and a quarter seconds—say at the rate of fifty in a minute or three thousand in an hour. These ideas, it must be

recollected are by no means atomic elements of thought; on the contrary, they are frequently glimpses over whole provinces of mental experiences and into the openings of far vistas of associations, that we know to be familiar to us, though the mind does not at the moment consciously travel down any part of them. Think what even three thousand such ideas would imply if they were all different! A man's autobiography, in two large volumes of five hundred pages each, would not hold them, for no biography contains, on an average, three such sequences of incident and feeling in a page. There must therefore be, of a necessity, frequent recurrences of the same thought; and this fact was brought out quite as prominently by these experiments as by my walks along Pall Mall. They were also elicited in a form in which I could submit them to measurement.

The 75 words gone through on four successive occasions made a total of 300 separate trials, and gave rise between them to 505 ideas in the space of 660 seconds. There were, however, so many cases of recurrence that the number of different ideas proved to be only 279. Twenty-nine of the words gave rise to the same thought in every one of the four trials, thirty-six to the same thought in three out of the four trials, fifty-seven to two out of the four, and there were only one hundred and sixty-seven ideas that occurred no more than once. Thus we see how great is the tendency to the recurrence of the same ideas. It is conspicuous in the reiteration of anecdotes by old people, but it pervades all periods of life to a greater extent than is commonly understood, the mind habitually rambling along the same trite paths. I have been much struck by this fact in the successive editions, so to speak, of the narratives of explorers and travelers in wild countries. I have had numerous occasions, owing to a long and intimate connection with the Geographical Society, of familiarizing myself with these editions. Letters are in the first instance received from the traveler while still pursuing his journey; then some colonial newspaper records his first public accounts of it on his reëntry into civilized lands; then we hear his tale from his own lips, in conversation in England; then comes his memoir read before the Society; then numerous public speeches, and lastly his book. I am almost invariably struck by the sameness of expression and anecdote in all these performances. (I myself went through all this, more than a quarter of a century ago, on returning from southwest Africa, and was quite as guilty of the fault as any one else.) Now, one would expect that a couple of years or more spent in strange lands among strange people would have filled the mind of the traveler with a practically inexhaustible collection of thoughts and tableaus; but no, the recollections tend to group themselves into a comparatively small number of separate compositions or episodes, and whatever does not fit artistically into these is neglected and finally dropped. We recollect very few of the incidents in our youth, though perhaps in old age we shall think very frequently of

that little. Let any man try to write his autobiography, say between the ages of five and six, and he will find that he has exhausted everything he can recollect of that period in a very few pages. Let him meet, for the first time after very many years, with some friend of his boyhood, and talk over some interesting event in which they were both engaged, and of which his recollection is so vivid that he believes he can have forgotten none of its incidents. He will assuredly find, if his experience at all resembles my own, that he and his friend have retained very different versions of the same occurrence, that in each case persons who had played an important part in it had wholly dropped from the memory, and that the conversation will have recalled many facts to both the speakers, that had almost passed into oblivion. We recollect the memories of incidents, or the memories of those memories, rather than the incidents themselves; and the original impression, like the original anecdote in the well-known game of "Russian scandal," receives successive modifications at each step until it is strangely condensed and transformed.

I divided such part of the 279 different ideas as admitted of it into groups, according to the period of my life when the association that linked the idea to the word was first formed, and found that almost exactly the half of those that recurred either twice, thrice, or four times, dated back to the period when I had not yet left college, at the age of twenty-two. Of those that did not recur in any of the trials the proportion that dated previously to the age of twenty-two to those of later date was a little smaller, viz., as three to four. All this points to the importance of an early education that shall store the mind with varied imagery, and may form just one half the basis of the thoughts in after-life.

The 279 different ideas fell into three groups. Those in the first and most numerous were characterized by a vague sense of acting a part. They might be compared to theatrical representations in which the actors were parts of myself, and of which I also was a spectator. Thus the word "a blow" brought up the image of a mental puppet, a part of my own self, who delivered a blow, and the image of another who received one; this was accompanied by an animus on my part to strike, and of a nascent muscular sense of giving a blow. I do not say that these images and sensations were vivid or defined—on the contrary, they were very faint and imperfect; indeed, the imperfection of mental images is almost necessary to mobility of thought, because the portions of them that are not in mental view or even in mental focus at the same instant admit of being changed to new shapes, and so the mental imagery shifts with less abruptness than it would otherwise do. The effect partakes more of the character of the changes in a diorama and less of that of a sudden transformation scene. I am not aware that this very common sort of ideas has ever been christened or even so clearly recognized before as I think it deserves to be; therefore I will

call it "histrionic." I find it to be a most important agent in creating generalizations.

The second group of ideas consists of mere sense imagery, unaccompanied by any obscure feeling of muscular tension or action; such as mental landscapes, sounds, tastes, etc. I showed, in a paper read before the Anthropological Society last year,[1] how generalized images admitted of being produced. I took a number of portraits of different persons, who were all represented in the same attitudes and of the same size, and I threw photographic images of these, one on the top of the other, by a contrivance there described, on the same sensitized photographic plates. The result was a picture compounded of that of all the different persons; and so much more numerous are the points of resemblance than those of dissimilarity in different human faces, that the composite picture looked as though it had been taken from a real living individual a little out of focus, and who had somewhat moved during the process. I then pointed out that "a composite portrait represents the picture that would rise before the mind's eye of a man who had the gift of pictorial imagination in the highest degree." It is clear, from the evidence of these composites, that generalized images are no chimeras.

So much for the second group of ideas. The third and last group consisted of purely verbal associations, whether the mere names of persons or things, or bits of quotations in prose or verse.

The seventy-five words were similarly divisible into three groups. The first included such words as "abasement," "abhorrence, "adoration," and "acclamation," all of which could be perfectly expressed in pantomime, and generally gave rise to histrionic ideas. The second group comprised "abbey," "aborigines," "abyss," and the like, all of which admitted of sense representation, either by a visual image, or, in the case of such a word as "acid," by some other sense. In the third group were the words "afternoon," "ability," "absence," "actuality," and others of a like abstract character, difficult to apprehend and realize, and tending to give rise to purely verbal associations. But as two ideas were registered on each occasion, the eight results were usually dispersed among all the groups, though in unequal proportions.

Experiments such as these allow an unexpected amount of illumination to enter into the deepest recesses of the character, which are opened and bared by them like the anatomy of an animal under the scalpel of a dissector in broad daylight. If we had records of the self-examination of many persons, and compared them, I think we should be much impressed by the differences between one mind and another, in the quality, wealth, and appropriateness of their associated ideas, and we should wonder that mutual misunderstandings were not more frequent even than they are.

[1] "Journal of the Anthropological Institute," viii., p. 134; or "Nature," May 23, 1878, p. 97.

I found the purely verbal associations to contrast forcibly in their rapid, mechanical precision with the tardy and imperfect elaboration of highly generalized ideas; the former depending on an elementary action of the brain, the latter upon an exceedingly complicated one. It was easy to infer from this the near alliance between smartness and shallowness.

It so happens that my mental imagery concerns itself more with aspects of scenery than with the faces of men, as I have rather a good memory for localities, and much pleasure in thinking about them, while I am distressed by natural inaptitude for recollecting features. I was therefore surprised to find that the names of persons were just twice as frequent in my associations as those of things, including places, books, and pictures. The associated words that formed parts of sentences or quotations were twenty-seven in number, and tended strongly to recurrence. The majority were of good verse or prose; the minority were doggerel. I may as well specify their origin. Four of the verse quotations were from Tennyson, two from Shakespeare, and eight from other sources partly doggerel. Of the prose, five were from the Bible, and seven from other sources, partly grotesque, and some of them family phrases. I suspect there is a great deal of rubbish in the furniture of all our brains.

The occasional vividness of an idea is very startling, and I do not see my way to explaining it fully; but sometimes I am sure it is due to the concurrence of many associations, severally of small intensity, but in the aggregate very effective. An instance of this is the powerful effect produced by multitudes subject to a common feeling of enthusiasm, religious fervor, or pure panic. On the few occasions on which I have had the opportunity of experiencing such manifestations, it seemed to me that every one of the multitudinous sounds and movements that reached the ear and eye, being inspired by a common feeling, added its effect to that of all the others. When we are in the presence of a single person or of a small company, the empty background fills a large part of the field of view, and dilutes the visual effect of their enthusiasm. Nay, the larger part of the forms of the persons themselves are similarly inexpressive, unless they be consummate actors. But nothing is seen in an enthusiastic multitude but excited faces and gestures, nothing is heard but excited voices and rustlings. Their variety is such that every chord in the heart of a bystander, that admits of vibrating in sympathy with the common feeling, must be stimulated to do so by some of them.

The background of our mental imagery is neither uniform nor constant in its character. It changes in color, tint, and pattern, though, in my case, all these are usually very faintly marked, and it requires much attention to study them properly. Its peculiarities have nothing to do with associated ideas; they appear to depend solely upon chance physiological causes, to which some of our ideas are also undoubtedly due.

The usual faintness of highly generalized ideas is forcibly brought home to us by the sudden increase of vividness that our conception of a substantive is sure to receive when an adjective is joined to it that limits the generalization. Thus it is very difficult to form a mental conception corresponding to the word "afternoon"; but if we hear the words "a wet afternoon," a mental picture arises at once that has a fair amount of definition. If, however, we take a step further and expand the phrase to "a wet afternoon in a country house," the mind becomes crowded with imagery.

The more we exercise our reason, the more we are obliged to deal with the higher order of generalizations and the less with visual imagery; consequently our power of seeing the latter becomes blunted by disuse. Probably, also, the mind becomes less able to picture things to itself as we advance in age. I am sure there is wide difference between my mental imagery now and what it was when I was a child. It was then as vivid and as gorgeous as in a dream.

It is a perfect marvel to me, when watching the working of my mind, to find how faintly I realize the meaning of the words I hear or read, utter or write. If our brain-work had been limited to that part of it which lies well within our consciousness, I do not see how our intellectual performances would rise much above the level of those of idiots. For instance, I just now opened a railway prospectus, and the following words caught my eye, the purport of which was taken in block, "An agreement will be submitted for the consideration and approval of the proprietors on Friday next"; yet I am certain that I had not, and I doubt if I could easily obtain, a good general idea corresponding to any one of the six principal words in the passage, "agreement," "submitted," "consideration," "approval," "proprietors," and "Friday." If I puzzle over the words in detail until I fully realize their meaning, I lose more than I gain; there is time for the previous words to slip out of mind, and so I fail to grasp the sentence as a whole.

The more I have examined the workings of my own mind, whether in the walk along Pall Mall, or in the seventy-five words, or in any other of the numerous ways I have attempted but do not here describe, the less respect I feel for the part played by consciousness. I begin with others to doubt its use altogether as a healthful supervisor, and to think that my best brain-work is wholly independent of it. The unconscious operations of the mind frequently far transcend the conscious ones in intellectual importance. Sudden inspirations and those flashings out of results which cost a great deal of conscious effort to ordinary people, but are the natural outcome of what is known as genius, are undoubted products of unconscious cerebration. Conscious actions are motived, and motives can make themselves attended to, whether consciousness be present or not. Consciousness seems to do little more than attest the fact that the various organs of the brain do

not work with perfect ease or coöperation. Its position appears to be that of a helpless spectator of but a minute fraction of a huge amount of automatic brain-work. The unconscious operations of the mind may be likened to the innumerable waves that travel by night, unseen and in silence, over the broad expanse of an ocean. Consciousness may bear some analogy to the sheen and roar of the breakers, where a single line of the waves is lashed into foam on the shores that obstruct their course.—*Nineteenth Century.*

HEALTH AND RECREATION.

By Dr. BENJAMIN W. RICHARDSON, F. R. S.

THAT all work and no play makes Jack a dull boy is one of those common sayings which we seem bound to accept, whether we like it or not. It is a truthful saying and an untruthful, a wise saying and an unwise, according as one word in it is interpreted, and that word is *play*. If play really means *play* in the strict sense of the term, as it is defined for us in the dictionaries, viz., "as any exercise or series of exercises intended for pleasure, amusement, or diversion, like blind-man's-buff"; or as "sport, gambols, jest, not in earnest"—then truly all work and no play makes Jack a dull boy, and Jill a dull girl.

But in these days there is a difficulty in accepting the saying as true, because the idea of play, especially when it is expressed by the term "recreation," is not always represented in the definition I have given above. We now often really transform play into work; and our minds are so constituted that what is one person's work is another person's play. What a backwoodsman would call his horse-like labor, a foremost statesman may call his light of pleasure. How shall we define it? What is play or recreation?

Men differ, I think, on the definition of work and play more than on almost any other subject: differ in practice as much as in theory in regard to it. I have had the acquaintance, and I may say the friendship, of a man who lives, it is said, for nothing but recreation, or pleasure, or play. Such a man will rise at ten in the morning, and after a leisurely, gossiping, paper-reading, luxurious breakfast will stroll to the stables to look after the horses, of each one of which he is very fond. He delights in horses. Thence he will away to the club, will gossip there, read the reviews or the latest new novels, and regale at luncheon. After luncheon he will play a rubber, winning or losing several shillings—it may be pounds. He may then take a ride, or drive, or walk in the park, and have a chat there; or canter over to Kew and look round the gardens, or attend a drum, or visit the Zo-

ological or Botanical Gardens. After this he will return home, and, ably and artistically assisted, will dress for dinner. The dinner, in accordance with his life, will be elegant, sumptuous, entertaining, whether he take it at his own table or abroad. After dinner he may probably go to a ball and dance until two or three in the morning; or, if there be no ball on hand, he may have another rubber, or a round at billiards, or a turn at the play, the opera, or the concert-room, with a final friendly chat and smoke before retiring for rest.

To this gentleman—and I am penciling a true and honest gentleman, not a modern rake of any school of rakes—this mode of life is a persistent pleasure, and to many more it would, I doubt not, be a perpetual holiday. To me it would be something worse than death. The monotony of it would be a positive misery, and I am conscious that many would be found to share with me in the same dislike.

Some will say that is all true enough with respect to persons who have passed out of youth into manhood, but that when life is young the distinctive appreciations for different modes of recreative pleasures are not so well marked out. I doubt, for my own part, this belief. It seems to me that in childhood the tastes for recreative enjoyment are as varied as they are in later years, with this difference, that they are not so effectively expressed. The little mind is ever in fear of the greater, and is often forced to express a gladness or pleasure which it does not truly feel. When children, left to themselves, are independently observed, nothing can be more striking to the observer than the difference of taste that is expressed in respect to the games at which they shall play. More than half the noise and quarrel of the nursery is, in fact, made up of this difference of feeling as to the character of the game that shall be constituted a pastime. In the end, on the rule, I suppose, of the survival of the fittest, the strongest children have their way, and one or two little tyrants drag the rest into their own delights.

I should, on the grounds here stated, venture, then, to say that there is, in point of fact, no more actual difference between work and recreation than what exists as a mere matter of sentiment: that recreation is a question of sentiment altogether, both in the young and the old.

If we could get this fact into our minds in our educational schemes for the young, we should accomplish at once a positive revolution in the training of the young, which revolution would, I think, be attended by the happiest change and train of thought in those who, in the future, shall pass through the first stages of life to adolescence and maturity. The search for amusements, and for new amusements, among the well-to-do would not be needed, since the mind from the first would be naturally brought to find a new delight in each act new called labor. The word "labor," in short, might drop altogether; the praise of labor, which is so often extolled, would find its true meaning; and the blame

of play, which is so often unduly criticised, would have its proper recognition.

It has always seemed to me that in that once high though brief development of human existence; in that period, if we can believe that the art of the period came from the life of it, when the human form took its most magnificent model for the artist still to copy; in that period when the perfection of bodily feature and build indicated, of itself, how splendid must have been the health of the living organizations that stood forth to be copied and recopied for ever—it has always seemed to me, I repeat, that in that wonderful period of Greek history, so effulgent and so short, the reason why such physical excellence was attained rested on the circumstance that among the favored cultivated few, for they were few, after all, there was from the beginning to the end of life no such thing as work and play. Everything was existence—nothing less and nothing more. Every office, every duty, every act must have been an existence for the moment, varied but never divisible into one of two conditions, practical pain or practical pleasure. Life was an enjoyment which nothing sullied except death, and which was purified even from death by the quick-consuming fire, that the life might begin again instantaneously and incorruptibly.

If by some grand transformation we could in our day approach to this conception which has been rendered to us by the history of art, and could act upon it, we should, in a generation or two, attain a degree of health which no sanitary provision, in the common meaning of that term, can ever supply. If we could turn our houses into models of sanitary perfection; if we could release our toiling millions from half their daily labor; if we could tell want to depart altogether; if we could give means of education to every living human being—we should not remove care, and therefore we should not secure health, unless with it all we could also remove the idea of the distinction of labor and pleasure, the morbid notion that some must work and some must play, that the world may make its round.

In this country, so differently placed to the country of the great and the ancient nation of which I have spoken, it is impossible, perhaps, ever to introduce a joyousness like to that which the favored old civilization enjoyed. Our climate is of itself a sufficient obstacle to such a realization. Where the physical conditions of life are so unequal, where we waste in structure of body, whether we will it or not, at certain fixed seasons, and gain, whether we will it or not, at other fixed seasons, it is impossible to attain such excellence by any diversion of mind or variation of pursuit. For universal gladness the sun must play his part, doing his spiriting gently, but never actually hiding the brightness of his face. From us, for long intervals, his face is hidden. Under these variations of the external light and scenery around us we have to cripple our minds through our bodies. Our clothing must be heavy during long stages of the year, and our food so comparatively

heavy and gross that half the power, which might otherwise go off in vivacity or nerve or spirit, is expended in the physico-chemical labor that is demanded for keeping the body warm and moving and living.

To these drawbacks is added the unequal struggle for existence, the partitioning off of our people into great classes, the millions of whom are obliged to work from morning to night, compared with the thousands who are at liberty to make some change in their course of life; the millions of adults who may be said to be tied to some continuous, monotonous round of labor, until the whole body lends itself to the task with an automatic regularity which the mind follows in unhappy and fretful train, with little hope for any future whatever on earth that shall bring relief.

From whatever side we look upon this picture it seems at first sight to present an almost insoluble problem, when the conception of mixing recreation with work, so as to make all work recreative, is considered. Among the masses there is no true recreation whatever, no real variation from the daily unceasing and all but hopeless toil; nay, when we ascend from the industrial and purely muscular workers to the majority who live by work, we find little that is more hopeful. There is no true recreation among any class except one, and that a limited and happy few, who find in mental labor of a varied and congenial kind the diversity of work which constitutes the truly re-creative and re-created life.

We get, in fact, a little light on the nature of healthful recreation as we let our minds rest on this one and almost exceptional class of men of varied life and action of a mental kind. They come before us showing what recreation can effect through the mere act of varying the labor. The brain-worker who is divested of worry is at once the happiest and the healthiest of mankind—happiest, perchance, because healthiest; a man constantly re-created, and therefore of longest life.

Dr. Beard, of New York, who has recently computed the facts bearing on this particular point, gives us a reading upon it which is singularly appropriate to the topic now under consideration. He has reckoned up the life-value of five hundred men of greatest mental activity: poets, philosophers, men of science, inventors, politicians, musicians, actors, and orators; and he has found the average duration of their lives to be sixty-four years. He has compared this average with the average duration of the life of the masses, and he has found in all classes, the members of which have survived to twenty years of age, the duration to be fifty years. He, therefore, gives to the varied brain-workers a value of life of fourteen years above the average. By a later calculation, relating to a hundred men belonging, we may say, to our own time, he has discovered a still greater value of life in those who practice mental labor, seventy years being the mean value of life in them. Thereupon he has inquired into the cause of these differences, so strange and so startling, and has detected, through this analysis, as I and others have, a combination of saving causes, the one cause most

influencing being the recreative character of the work. His observation is so sound, so eloquent, and above all so practical, that I can feel no necessity for apology in giving it at length. He is comparing, in the passage to be quoted, what he calls the happy brain-worker with the mere muscle-worker, and this is the argument:

> Brain-work is the highest of all antidotes to worry; and the brain-working classes are, therefore, less distressed about many things, less apprehensive of indefinite evil, and less disposed to magnify minute trials, than those who live by the labor of the hands. To the happy brain-worker life is a long vacation; while the muscle-worker often finds no joy in his daily toil, and very little in the intervals. Scientists, physicians, lawyers, clergymen, orators, statesmen, literati, and merchants, when successful, are happy in their work without reference to the reward; and continue to work in their special callings long after the necessity has ceased. Where is the hod-carrier who finds joy in going up and down a ladder; and, from the foundation of the globe until now, how many have been known to persist in ditch-digging, or sewer-laying, or in any mechanical or manual calling whatsoever, after the attainment of independence? Good fortune gives good health. Nearly all the money in the world is in the hands of brain-workers; to many, in moderate amounts, it is essential to life, and in large and comfortable amounts it favors long life. Longevity is the daughter of competency. Of the many elements that make up happiness, mental organization, physical health, fancy, friends, and money—the last is, for the average man, greater than any other, except the first. Loss of money costs more lives than the loss of friends, for it is easier to find a friend than a fortune.

The contrast put before us in these forcible remarks is most striking. It is the key to the position in trying to unlock the secret as to what true recreation should be. These brain-workers of whom Dr. Beard speaks are, indeed, the modern Greeks, not perhaps in perfection but in approximation. The Greeks might, possibly, have gone higher than they did in the way of developed physical beauty and of mental endowment, and these happy brain-workers of later ages might, perhaps, more nearly approach the happy Greeks. But both were on the lines toward the highest that may be attainable, and this, as a means of indicating the right line, is my reason for using the illustrations that have been offered.

That which I have so far urged consists, then, of two arguments: Firstly, that recreation to be healthful must, as its meaning conveys, literally, be a process of re-creating; that is, of reconstructing or rebuilding; a practice entirely distinct from what is called play, when by that is meant either cessation from every kind of creation, or enjoyment of abnormal pleasures which weary mind and body. Secondly, that they who are able to live and re-create in the manner suggested are, in positive fact, they who present the healthiest, the happiest, and the longest lives.

From these premises I further draw the conclusion that we have no open course of a reasonable kind before us except to strive to beget a healthful recreation in the direction indicated.

At the same time I do not say this in order to divert attention from what may be rightly called the natural animal instincts of man. I have no doubt there might be a cultivation of mind which should cease to be recreative, and which thereby should be as injurious to the health of the body as an over-cultivation of mere gross mechanical labor, and which might even be more dangerous. It is not a little interesting to observe that the greatest of the Greeks had become conscious of this very danger, as if he had learned its existence from observations in his daily life. Plato, in treating of this subject in one of his admirable discourses, warns us against the delusion that the cultivation of nothing but what is intellectually the best is, of necessity, always the best. It is more just, he says, to take account of good things than of evil. Everything good is beautiful; yet the beautiful is not without measure. An animal destined to be beautiful must possess symmetry. Of symmetries we understand those which are small, but are ignorant of the greatest. And, indeed, no symmetry is of more importance with respect to health and disease, virtue and vice, than that of the soul toward the body. When a weaker and inferior form is the vehicle of a strong and in every way mighty soul, or the contrary; and when these, soul and body, enter into compact union, then the animal is not wholly beautiful, for it is without symmetry. Just as a body which has immoderately long legs, or any other superfluity of parts that hinder its symmetry, becomes base, in the participation of labor suffers many afflictions, and, though suffering an aggregation of accidents, becomes the cause to itself of many ills, so the compound essence—of body and soul—which we call the animal, when the soul is stronger than the body and prevails over it—then the soul, agitating the whole body, charges it with diseases, and by ardent pursuit causes it to waste away. On the contrary, when a body that is large or superior to the soul is joined with a small and weak intellect, the motions of the more powerful, prevailing and enlarging what is their own, but making the reflective part of the soul deaf, indocile, and oblivious, it induces the greatest of all diseases, ignorance. As a practical corollary to these remarks, Plato adds that there is one safety for both the conditions he has specified: neither to move the soul without the body, nor the body without the soul. The mathematician, therefore, or any one else who ardently devotes himself to any intellectual pursuit, should at the same time engage the body in gymnastic exercises; while the man who is careful in forming the body should at the same time unite the motions of the soul, in the exercise of music and philosophy, if he intends to be one who may justly be called beautiful and at the same time "right good."

Such is the Platonic reading of the recreative life as it appeared to him in his day and among his marvelous people. We have but to trouble ourselves with half the problem he refers to, and with but half the advice that he suggests. Little fear, I think, is there among us that the soul should be so much stronger than the body, and so greatly

prevail over it that it should agitate the whole inwardly, and by ardent application to learned pursuits cause the body to waste away. Nor is this to be regretted, because if the danger so stated were a prevailing one we should have two evils to cure in lieu of one which is all-sufficient for the reforming work of many of the coming generations of men.

I have not, I trust, dwelt too long on what I may call the practical definition of recreation as it ought, I think, to be understood, as it once was understood and practiced, and as it is still practiced, if not systematically understood, by a few whose varied and delightful works and tastes make them the healthiest and longest-lived among us.

It is well always to have a standard before us, though it be seemingly unapproachable, and the illustrations I have endeavored to supply of all work and all play, and of long-continued recreation thereupon, form the standard I now wish to set up for observation.

To make all England, and all the world, for the matter of that, a recreation ground; to make all life a grand recreation; to make all life thereby healthier, happier, and longer—this is the question before us.

Confining our observations to our own people and time, it may now be worth a few moments of analytical inquiry as to how far we, in different classes of our English community, are away from so desirable a consummation—the consummation of all human effort toward the perfected human life: the dream of some poets that such a life has been and will return—"Redeunt Saturnia regna"—the dream of many poets that it is to be, if it has not been.

The Registrar-General, with much judgment, due to long and wide experience of the component parts of the nation comprised under the title of England and Wales, has divided the community into six great classes, which classes are, in many respects, so distinct that they may almost be considered as great nations of themselves, having their own individual pursuits, habits, tastes, and, if the word be allowable, recreations. He describes for us—1. A professional class, made up of governing, defending, and learned persons, and numbering some 684,102 persons, chiefly of the male sex; 2. A domestic class, wives and women of the household, and hotel and lodging-house keepers—a large class, the great majority women, numbering as many as 5,905,171—nearly, in fact, six millions; 3. A commercial class of buyers, sellers, lenders, and transporters of goods and produce, chiefly men, and numbering 815,424; 4. An agricultural class, cultivators, growers, and animal-keepers, the majority men, numbering 1,657,138; 5. An industrial class, mechanics, fabric manufacturers, food and drink producers, and purveyors of animal, vegetable, and mineral produce—a very large class, having in it members of both sexes, and numbering 5,137,725; 6. An indefinite, non-productive class; persons of rank and property; and scholars and children; nearly an equality of representation of numbers of both sexes; the whole class including a total of 8,512,706, of whom 7,541,-

508 are scholars and children—the living capital of the next generation of men and of women.

As we glance at these classes we quickly detect that what may be called their vocations are extremely different; that each class—with the exception, perhaps, of two, the professional and the commercial, with that part of the indefinite class which is composed of persons of rank and property, and which approach each other—are as widely separated in tastes and habits and inclinations as they are in labors and works. Looking at the education of body and mind in these classes as a whole, there is certainly little enough of symmetry.

Among the representatives of these classes which are best able to command the advantages of true recreation there is little sound attempt to use the privilege in a refined and reasonable way. The persons who have their time at command, and who belong to the most favored division, are divisible into two groups: a group which does no work at all that can bear the name of useful or applied labor, but which spends all its waking hours at what it considers to be recreative pursuits, which may be laborious, but must not be remunerative; and a group which labors industriously for the sake of return or reward, but which steals from time of labor regular intervals in which to follow out certain of the recreations which form the whole life of the first group, in strict imitation of that envied group, and in hopeless neglect of any recreation of its own better adapted to its real wants and best enjoyments. Each of these groups suffers from the course it follows. The representatives of the first kind lose much, since they are for ever repeating the same to them pleasurable or automatic activity. The second lose, because, while they are ever repeating the same useful activity, they are only relieving that activity by repeating day after day the same automatic and imitative recreations. Thus both are subjected to what may be called the automatism of recreation. The automatism of recreation is bad in every sense, and it is specially bad in the present day, because of the quality of it, as well as the limited quantity. There is no such diversity of recreation as is wanted to keep the body in health by the exercise of the mind. With one man the recreation is all taken out in cards, with another in chess, with a third in billiards, with a fourth in debate or gossip on some one persistent topic of discourse or argument, and so on, for what may be called the in-door recreative life. Nor is it much different with out-door recreative amusement. Some one particular amusement claims the attention of particular men, and to this amusement the men adhere as if they had to live by it, and as if, in fact, there were no other recreative pursuits in the world.

This specialty of recreative pleasure or labor—for soon it becomes labor—leads to consequences which are often of the most serious character. The man who undertakes the recreation at first as an enjoyment, and indeed as a relaxation, is so absorbed in it that he strains every nerve to be eminent in it, a professor of the accomplishment, with

a local repute for his excellence. The moment he enters on this resolve, however, he loses recreation. He sets himself to a new work, be it mental or physical; his mind becomes an emporium for the produce of that one particular culture, and he is in respect to that not far removed from a monomaniac. From the day that he is completely enamored of the special pursuit it is little indeed that he is good for out of it in hours apart from the common vocation of his life. He becomes fretful if for a day he be deprived of his peculiar gratification; irritable if he joins with others in it who are not so skillful as himself; envious if he meets with a rival who is better at it than himself; and often actually sleepless in thinking and brooding over some event or events that have been connected with the previous play or venture.

If the time at my disposal admitted the introduction of detailed illustration of the facts here referred to, I could supply from experience instance upon instance. I have seen an amateur chess-player so infatuated with the game, which he originally sat down to as a relaxation, that he became for months a victim of insomnia. He carried the whole chess-board, set out in various difficult problems, in his brain, if I may use such a simile, studied moves on going to sleep, dreamed of them, woke with the solution solved, was sick and feeble and irritable all next day, followed his usual occupation with languid ability and interest, resumed his play at night with excited but not recruited determination, got more and more sleepless, and at last failed to sleep altogether. I have known more than one similar illustration in whist-players and in great billiard-players, and have seen the results of these so-called recreations end in the most sad physical disaster, when the pursuit of them has been made a matter of living importance, and when the player has ever had in his mind that pitiful *if:* "If I had done this or that—if I had made that move on the board—if I had played that card—if I had made that stroke, how would the case have been?" It matters little what the answer to the question may be—whether it be that by such a move, card, or stroke, the game would have been lost or won; the perplexing doubt is there to annoy, and it keeps up an irritation which imperceptibly wears out the animal powers and does permanent injury to life. You see men while still they are actually young grow rapidly like old men under this supposed recreative strain. They grow prematurely careworn, prematurely gray, prematurely fixed in idea and obstinate in idea, angry at trifles, baffled by trifles, and, in a word, young senilities.

In this busy city, in the great places of business near to which we now are, there are hundreds—may I not extend the calculation and say thousands?—of men who, in pursuit of the recreative pleasures I have specified, or of others similar in their results, are wearing themselves out twice as fast—and more than twice—as they are by the legitimate labor to which they have to apply themselves that they may earn their daily bread. It is the fact; and the observant physician, as he listens

to the suffering statements of these men, is obliged in his own mind to differentiate between the assigned and what is often the real cause of that train of evils to which it is his duty to lend an attentive ear.

Thus, among the most intelligent part of the community—among the part that can help itself—there is no systematized scale or class of recreations that can be relied upon to afford the change really demanded for health. Nor are matters much improved when we take up the kind of change that is sought after by the same classes in the matter of physical recreation. When the Volunteer movement first came under notice, and for some time after it first came into practice, it was the hope of all sanitary men—I believe without any exception—that the exercise, and drill, and training, and excitement which would be produced by the movement would prove most beneficial to the health of the male part of the people at a period of life when the training of the physical powers is most required and often most neglected. I remember being quite enthusiastic at that change and its promises, and I recalled the other day an often-quoted paper or essay which had sprung out of that enthusiasm, and which I dare say at the time it was written seemed common sense itself. I can but feel now that the hope was begotten of inexperience. The movement has been a success, I presume, in a national and political point of view, but a careful observation of it from its first until this time has failed to indicate to me, as a physician, that it has led to any decided improvement in the health generally of those who have been most concerned in carrying it out by becoming its representatives. Certain it is that nothing affirmative of good stands forth in its favor, and I wish I could stop with that one neutral statement. I can not in order of truth and fairness so stop, for I have seen much injury from the process. To say nothing of the expense to which it subjects many struggling men, to the loss of time it inflicts on them, to the neglect it inflicts at the fireside and home, to the spirit of contest of mind and fever of mind which it engenders; to say nothing, I repeat, of these things—all of which, nevertheless, are detrimental, indirectly, to the health of the men themselves and of those who surround them in family union—there is a direct harm often inflicted by the service, call it recreation if you like, which is not to its credit. The man who has advanced just far enough in life to have completed his development of growth, and to have lost the elasticity of youth, the man who has rather too early in life become fat and, as he or his friends say, puffy, the man who has, from long confinement in the office or study, found himself dejected and dyspeptic, each one of these men has passed into the ranks of the Volunteers, in order to regain the elastic tread, to throw off the burden of fat, or to find relief from the dyspeptic despondency. For my part, I have never been able to discover a good practical result in any of these trials; but I have seen many bad practical results. I have seen the partly disabled men, in the conditions specified, striving to do their best to keep alive and

be on a level with younger and athletic men, and I have been obliged to hear of the signal and natural failure of the effort. I have heard of the attempts to meet the failure by the tempting offer and too willing acceptance of what are called artificial stimulants to give temporary support, and I have been obliged to discover in persons so overtaxed and so over-stimulated a certain heavy excessive draw on the bank of life, an anticipation of income which, in the vital as surely as in the commercial world, is the road to a premature failure and closure of the whole concern.

There are many who will agree with me, I doubt not, on this point; there are many men, and there are more women—for wives and mothers are far more observant and wise than husbands and fathers on these points—who will be able to bring their experience to bear in confirmation of that which I have spoken; and these will agree that to put men of different ages and of different states of constitution and habits in the same position for recreation; to trot them all through the same paces; to make them all wear the same dress, walk or march the same speed, carry the same load, labor the same time, move the limbs at the same rate; that to construct one great living machine out of a number of such differently built machines is of necessity an unnatural and, in the end, a ruinous process. There are some, however, who, while admitting so much, will put in a plea for the younger members of the community. They will insist that the younger men, the men who are from nineteen or twenty up to twenty-nine or thirty, may with advantage go through the recreation of training after the Volunteer fashion. The case is much stronger on behalf of this argument, but even in the respect named there requires a great deal of discrimination. A race of strong men may be bred, and a weak race may, by gradual development, be raised into a strong; but a weak man, born weak, can, through himself, be led a very little way into strength; while during the process of training he can most easily be broken into utter feebleness, so that the last of the man may be worse than the first. Hence, in training the weak into strong through any form of recreation, mental or physical, but specially physical, there must be a singular discrimination. In this instance of Volunteering as a mode of progress in physical health for the young there are dangers that ought to be avoided with religious care. To advise a weakly youth of consumptive tendency and feeble build, or one having some special proclivity to rheumatic fever, heart-disease, or other well-defined hereditary malady, to compete with other men of the same age and of athletic nature, in the same recreative exercise, is to deceive the youth into danger. To force such a one into violent competitive exercise, and tax him to the same degree of vital withdrawal day after day, or week after week, is to subject him all but certainly to severe, if not fatal, bodily injury.

I have selected the recreative exercise of Volunteering as a case for illustration of an important lesson, and I have made the selection, not

because the recreation is special as a sometimes harmful recreation, but because more persons are concerned in it just now than in aught else of the same kind of recreative pursuit.

There are many other so-called recreations which are even more injurious to the feeble adolescent and to the enfeebled matured individuals, who seek to find symmetry of health in extreme recreation. Football is one of these recreations fraught with danger. Rowing is another exercise of the same class. Polo, while the fever for it lasted, was found to be of similar cast. Excessive running and prolonged and violent walking—in imitation of those poor madmen whose vanity trains them to give up sleep and all the natural ordinances that they may walk so many thousand miles in so many thousand hours—these are alike injurious as physical recreations unless taken with the same discrimination as is required by those who enter into the Volunteer movement.

As we pass from the freer and wealthier classes of the community into the less prosperous we find no marked improvement whatever in any form of recreation. We begin, in fact, to lose sight of the recreation that ministers to either mind or body in a sensible and healthy degree, and to see that which should be recreative replaced almost entirely by continuous and monotonous labor. The idea of symmetry of function and development between mind and body disappears nearly altogether; so that, indeed, to mention such a thing would, in some of the classes concerned, be but to treat on a subject unknown, and therefore, as it would seem to them, absurdly unpractical. To tell a country yokel that his body is not symmetrical in build, and that his mind has no kind of symmetrical relation to his body, were cruel, from its apparent satire. Yet why should it be? Why should ignorance and labor so deform any one that the hope of a complete reformation, the hope of the constitution of a perfect body and in it a perfect mind, should seem absurd? It is not the labor that is at fault. The labor is wholesome, healthful, splendid; it is a labor compatible with the noblest, nay, the most refined of human acquirements. Why should it be incompatible with perfect physical conformation of mind and body? It is not, indeed, the labor that is at fault, but the ignorant system on which it is carried out.

There is much difference, in fact, between the three classes of the community called the domestic, the agricultural, and the industrial, in respect to the work, the recreation, and the resultant health pertaining to each class. The domestic class as a whole is, by comparison with the industrial, fairly favored. The members of it lead, it is true, a monotonous life, and see often but little of the beauties of external nature, but they find in the amusements they provide for those who are about them some intervals of change which are, as far as they go, of service. Moreover, except in that part of the class which is engaged in disposing of spirituous drinks, and which pays a heavy vital taxation from the recreation springing out of that vocation, its representatives are not exposed

to harmful recreations to an extreme degree. The domestic class therefore presents, on the whole, a fairly healthy life. The majority of its members are women and mothers; and, in the gladness with which they tender their love and adoration to the young and innocent life that comes into their charge, they find perchance, after all, the purest pleasure, the most enhancing, the most ennobling recreation, that, even in the midst of many cares and sorrows and bereavements, falls to the lot of any section of the great community.

The agricultural class, less favored in recreative opportunities than the others which have passed before us, living a laborious and very poor life, ever at work for small returns, and finding little recreation beyond that which is of mere animal enjoyment, is still comparatively favored. To the agricultural worker the seasons supply, imperceptibly, some delight that is beneficial to the mind.

> These as they change, Almighty Father! these
> Are but the *varied* God.
> Mysterious round! What skill, what force divine
> Deep felt in these appear: a simple strain,
> Yet so delightful, mixed with such kind art,
> Such beauty and beneficence combined,
> And all so forming one harmonious whole—
> Shade unperceived, so soft'ning into shade
> That as they still succeed they ravish still.

The labor of the out-door agricultural class, blessed by these changing scenes which the exquisite poet above quoted so exquisitely describes, is varied also in itself. Each season brings its new duty: the spring its meadow-laying and sheep-shearing; the summer its haymaking; the autumn its harvesting and harvest-home, and fruit-gathering; the winter its plowing and garnering, and cattle-tending; with sundry well-remembered holidays which are religiously kept. There may be through all this continuous wearing labor; there is; but, as it is not monotonous, it is to some extent recreative, and the facts of mortality tell that it is saving to life. The agricultural classes present a mortality below the average in the proportion of ninety-one to one hundred of the mass of the working community. Moreover, there is hope for the agricultural classes in the fact that it is comparatively an easy task to supply them with a perfect roundelay of beautiful recreations for their resting hours. It is only to remove from them the grand temptations to vice in the beer-shop and the spirit-store, and to substitute for these resorts a rational system of enjoyments, to win for the country swain the first place in that symmetry which Plato called "right good."

The utter blankness, the blankness that may be felt, in respect to recreation is realized most in the millions of the industrial class who live in the everlasting din of the same mechanical life; who see ever before them the same four walls, the same tools, the same tasks; who

hear the same sounds, smell the same odors, touch the same things, feel the same impressions, again and again and again, until the existence is made up of them, never to be varied until death doth them part. It is to this class—repining, naturally envious, naturally restless, and at this moment of time unsettled, mournful, and disaffected, to an extent which few, I fear, of our rulers comprehend—it is to this class most of all that the balm of wholesome recreation is most necessary, and for whom the absence of it is most dangerous. In this class there is no such thing as health. It is a blessing not to be found. You could not, I solemnly believe, bring me one of them that I dare, as a conscientious physician, declare, after searching examination, to be physically healthy in any approach to a degree of standard excellence. As a rule the average of life among those who have passed twenty-five would not be above fifteen years.

In these classes we see the effect of what I may venture to call the denseness of work, leading to mortality in the most perfect and distinctive form—work without any true recreative relief; work without anything changing or becoming recreative in itself; work relieved at no regular intervals for introduction of new life.

The greatest of all the *social* problems of our day is involved in this study of the manners and modes of thought of over five millions of adult English people, all confined in order that they may labor, with no satisfactory relief from labor, and with no land of promise before them. The greatest of all the *political* questions of our day is also involved in this same study. The physician knows that the wisest of mankind, the most intelligent of mankind, are only half their former selves when they are out of health. He knows that health which is bad, but not sufficiently bad to prostrate the physical powers to such an extent as to cause inactivity of the will, is the most perplexing of all states of mind and action with which he has to deal. He feels thereupon a fellow-sympathy with the political physician who is called upon to treat the industrial masses in mass; to provide for their minds' health, to calm their excitement, to plant confidence in their hearts, and, most arduous task of all, to find out the way for securing for them those two grand remedies in the Pharmacopœia of the ordinary physician, rest and change of scene, in pure and open air.

"They find their own recreations, these working millions," I think I hear some one say. They *try* to find them, would be the truer statement. They try their best, but they have found few conducive to health, many that are fatal. They are to be pitied and pardoned for these errors of their finding. What if they do discover recreation of the worst kind in the bar and saloon of the spirit-seller? Have they not the example of the wealthier classes before them, teaching that the same indulgence, in another style, is recreation? May they not ask how many other obtainable pleasures are provided for them, and whether many, too many, of obtainable pleasures so called, and so bad,

are not positively thrust upon them? They have labored all day in monotony: where shall they go for recreation, and what shall the recreation be? If they go far away they are removed from the sphere of their labors; if they look near to their own abodes, they find not one true and ennobling pastime, but fifty that are degrading, and, at the same time, filled with every possible temptation.

I apply this to our own people; but it is, I fear, equally applicable to other peoples. Dr. Beard, the American I have already quoted, writes his experience, gathered in his own country, as follows: "To live," he says, speaking of the same classes, "to live on the slippery path that lies between extreme poverty on the one side and the gulf of starvation on the other; to take continual thought of to-morrow, without any good result of such thought; to feel each anxious hour that the dreary treadmill by which we secure the means of sustenance for a hungry household may, without warning, be closed by any number of forces, over which one has no control; to double and triple all the horrors of want and pain by anticipation and rumination—such is the life of the muscle-working classes of modern civilized society; and when we add to this the cankering annoyance that arises from the envying of the fortunate brain-worker, who lives at ease before his eyes, we marvel not that he dies young, but rather that he lives at all."

There remains still in the list of classes requiring recreation, and the health that springs from it, the last or indefinite class. Of the purely indefinite of these I need not speak; for they, the waifs and strays of our civilization, are, I fear, under little influence of such refining agencies as we would put forward for the future. With the very small class of persons of rank and property, less than 169,000 altogether, I have dealt already, by joining them with the professional and commercial well-to-do classes. To the seven and a half millions of scholars and children and their recreations attention will be called in a new chapter.—*Gentleman's Magazine.*

EARLY TRACES OF MAN.[1]

By G. DE MORTILLET.

QUATERNARY MAN.—The man of geological time—fossil man—is now a fact so clearly demonstrated that it is no longer called in question. The recent exposition of anthropological sciences showed us his works plentifully scattered throughout France, England, Spain, and Italy.

But, though the existence of quaternary man in the southwest of Europe is no longer denied, there is a school which, walking with fear

[1] Translated by J. Fitzgerald, A. M., from the "Revue d'Anthropologie."

and hesitation in the path of progress, has its mind made up to contest his existence in the Orient. What the leaders of this school maintain is this: In the East, say they, civilization, and consequently historic records, date back to a very remote time. Is it not, then, possible that geological time still persisted in Europe, and especially in western Europe, while in Egypt the historic dynasties were being founded?

To put forth such a proposition as this, one must be ignorant of the data of geology. The remarkable collections exhibited at the Anthropological Exposition have shown that man was contemporary not only with the reindeer, the saiga, the chamois, and the marmot on our plains; not only with the mammoth, and the *Rhinoceros tichorhinus* —that is, with the fauna of the glacial period—but also with the great hippopotamus, the *Elephas primigenius*, and the rhinoceros of Merk. All geologists are agreed that the duration of the period in which we live is as nothing compared with that of the Quaternary period. It is as a day compared to ages, as a drop of water in a stream. All paleontologists understand what a length of time is requisite for the rise and decline of animal species—species which, while they have been upon the earth, have been lavishly distributed over an enormous area.

But we have no need of the general data of geology and paleontology in order to meet the objection. The Exposition of the Anthropological Sciences furnished materials which reduce it to a nullity. There were exhibited perfectly characterized quaternary instruments of silex from the East—from the most ancient seats of civilization, Egypt and Syria. In those countries then, no less than in France and England, quaternary man preceded all the historic civilizations.

The earliest Quaternary epoch, the preglacial, is characterized, so far as man's works are concerned, by a stone implement of peculiar form. It is dressed on its two sides, usually rather roughly chipped; it is rounded at the base, pointed at the top, and its edges are pretty sharp. In general form it is more or less almond-shaped. This implement, in past times called by workmen in quarries "langue de chat" (cat's tongue), is now called "hache de St. Acheul," or "hache acheulienne" (hatchet of St. Acheul), terms derived from the locality in which it has been oftenest found. They have been found in abundance in the quaternary alluviums of France, England, and Spain. Nay, within a few years they have been found in the valley of the Delaware near Trenton, New Jersey, by Dr. Charles C. Abbott. The figures which he has published, and his descriptions, tally exactly with the St. Acheul hatchets of France and England.

Nor is it in the New World only that the existence of man in the earliest portion of the Quaternary period has been proved; the same thing is true of the Old World. M. Place, the explorer of Assyria, has brought to light a St. Acheul hatchet of silex which he found under the ruins of the palace of Khorsabad. At the exposition, the Abbé Richard showed a St. Acheul hatchet, also of silex, from the lake of Tiberias.

A still more conclusive proof is furnished by Professor Henry W. Haynes, of Boston, who reports a number of wrought flints from Egypt, among them several clearly characterized St. Acheul hatchets.

In the February number (1869) of the "Matériaux pour l'Histoire de l'Homme," M. Adrien Arcelin first made the announcement that the grand Egyptian civilization, like all other civilizations, was preceded by an age of stone. He had just collected in Upper Egypt several chipped flints. Toward the close of the same year this discovery was confirmed by Messrs. Lenormant and Hamy. All the specimens brought home by these earliest explorers might be regarded as belonging to the Robenhausen epoch, or age of polished stone—only one specimen, presented to the museum of St. Germain, came anywhere near the St. Acheul type.

After Arcelin's discovery, collections of dressed flints were multiplied in Egypt, though without throwing much light upon the question. But Sir John Lubbock, in an essay illustrated with fine plates, gave figures of three flint implements found at Luxor and at Abydos, which are undoubtedly St. Acheul hatchets.

Among the wrought flints brought from Egypt and exhibited by Mr. Haynes are several which incontestably are of the quaternary type. Among them we see scrapers and arrow-heads, the latter belonging to a type which in France occurs only in glacial formations. The collection also embraces more ancient forms, preglacial forms, referable to the early portion of the Quaternary period, viz., St. Acheul hatchets of flint.

These St. Acheul hatchets come from two very distinct localities: one lot is from the neighborhood of Luxor, in Upper Egypt, the other from the environs of Cairo, in Lower Egypt. The flint used, as is clearly proved by Delanoue, comes from the nummulitic formations. These formations are found *in situ* in Upper Egypt; and the St. Acheul hatchets of that region are as a rule heavier and better wrought, above all, more completely wrought. In the environs of Cairo there are no rocks *in situ;* and, as for flint, only rounded nodules are found. These nodules have been wrought into the forms of implements. This is easily seen, for all the St. Acheul hatchets of that locality still bear at their base traces of the original rounded surface of the nodules.

From these archæological data, i. e., from the nature and the form of the objects, we may conclude that the man of the earliest Quaternary times lived in Egypt simultaneously with his existence in Europe, and that in both of these regions his industrial development was about the same, extremely primitive.

And geological observation confirms these deductions. It was not on the surface of plateaus that Mr. Haynes found these St. Acheul implements. On the contrary, most of them, at least those from the neighborhood of Luxor (forming the greater number), were found in the bottom of the ravines of Bab-el-Moluk. These ravines are cut deep

into the quaternary deposits by the torrents which, in seasons of heavy rainfall, carry to the Nile the waters from the mountains of Libya.

Thus, then, thanks to the Exposition of the Anthropological Sciences, we are in a position to show that the oldest Egyptian civilization —that of the earliest dynasties—which dates back 4,000 years before our era, was preceded by an age of polished stone, and that before that period Egypt, like all the rest of the world, was occupied by quaternary man.

TERTIARY MAN.—Important as are the results of the Anthropological Exposition from the point of view of quaternary man, they are still more so from the point of view of tertiary man.

But first let us understand what is meant by the terms quaternary man and tertiary man.

The fauna of the mammals serves clearly to determine the limits of these later geological periods.

The Tertiary is characterized by terrestrial mammals entirely different from extant species; the Quaternary by the mingling of extant with extinct species; the present period by the extant fauna.

The man of the early Quaternary, he who made the St. Acheul hatchets and used them, is the man of Neanderthal, of Canstatt, of Enggisheim, of La Naulette, of Denise. He is indubitably a man, but differing more widely from the Australian and the Hottentot than the Australian and Hottentot differ from the European. Hence unquestionably he formed another human species, the word species being taken in the sense given to it by naturalists who do not accept the transformation doctrine.

Tertiary man, therefore, must have been still more distinct—of a species still less like the present human species—indeed, so different as to entitle it to be regarded as of distinct genus. For this reason I have given to this being the name of man's precursor. Or he might be called anthropopithecus—the man-monkey.

The question of tertiary man should therefore be expressed thus: Did there exist in the Tertiary age beings sufficiently intelligent to perform a part of the acts which are characteristic of man?

So stated, the question is settled most completely by the various series of objects sent to the Anthropological Exposition.

The first and oldest of these collections was that made by the late Abbé Bourgeois, at Thenay (Loir-et-Cher). At the International Congress of Prehistoric Archæology and Anthropology, held in Paris in 1867, the Abbé Bourgeois exhibited tertiary flints which, he claimed, had been chipped intentionally. These early specimens were not very conclusive, lost as they were amid a multitude of other specimens which certainly had not been fashioned intentionally, unless one can suppose that they had been intentionally split by the action of fire. The result was, that the abbé's communication won to his side but few adherents.

But, profoundly convinced of the reality of his discovery, the Abbé Bourgeois did not lose heart on suffering this partial repulse. He continued his researches with vigor, and again, in 1872, provided now with better specimens, he raised the question at the Brussels Congress. There he made some headway among the best experts. But on the commission which was specially appointed to examine the flints were several members who knew but very little directly about the manner of working on flint, and they either hesitated or passed an adverse judgment. Hence the question was not definitively settled. This result, half success, half failure, stimulated the ardor of the accomplished naturalist; he continued his investigations, and so succeeded in collecting for the Anthropological Exposition a remarkable series of flint implements which dispels all doubt.

This collection was made up of flints which beyond a doubt had undergone the action of fire. They are full of cracks, and even quite discolored. With these are other flints, far more numerous, which have simply been split by fire. Among them are some which unquestionably have been neatly and regularly retouched on one or both of their margins. Every one who has carefully and impartially examined them has admitted that the second dressing (*les retailles*) was certainly intentional, and consequently that it was the work of an intelligent creature.

It remains to determine the age to which these flints belong. They were collected at Thenay, in formations clearly *in situ* and intact, and belonging to the formation known among geologists as "calcaires de Beauce"; but now these calcaires de Beauce constitute the lower strata of the Middle Tertiary. This is shown by the fauna which the Abbé Bourgeois exhibited in connection with the flints. This fauna, which comes from the sands of the Orléanais, which directly overlie the calcaires de Beauce, comprises great mastodons and dinotheriums belonging to the Lower Miocene. Then there is the acerotherium, a genus akin to the rhinoceros, and which was found in the very same stratum as the fire-split and redressed flints.

It results, therefore, from the Abbé Bourgeois's researches, that during the Middle Tertiary there existed a creature, precursor of man, an anthropopithecus, which was acquainted with fire and could make use of it for splitting flints. It also knew how to trim the flint-flakes thus produced and to convert them into tools.

This curious and interesting discovery for a long time stood alone, and arguments were even drawn from this isolatedness to favor its rejection. Fortunately, another French observer, M. J. B. Rames, has found in the vicinity of Aurillac (Cantal) in the strata of the upper part of the Middle Tertiary—here, too, in company with mastodons and dinotheriums, though of more recent species than those of Thenay—flints which also have been redressed intentionally. Here, however, the flints are no longer split by fire, but by tapping. It is something more than a continuation, it is a development. Among the few speci-

mens exhibited by M. Rames, whose discoveries are quite recent, is one which, had it been found on the surface of the ground, would never have been called in question.

The weighty facts developed by French investigators received striking confirmation in the Portuguese department of the Exposition. A distinguished *savant* of Lisbon, Senhor Ribeiro, director of the Geological Bureau of Portugal, sent a collection of flints and quartzites found in the strata of the Middle Tertiary or Miocene and in the Upper Tertiary or Pliocene of the valley of the Tagus. Among these specimens—ninety-five in number—are twenty-two which bear unquestionable traces of intentional chipping. Nine specimens, all of flint, are described as coming from the Miocene. Of the others, purporting to be Pliocene, seven are of flint and six of quartzite. All these specimens are roughly chipped, and nearly all are triangular in form, and not redressed, whether the material be flint or quartzite.

Thus, then, the Anthropological Exposition, important though it was from the point of view of quaternary man, is still more important from the point of view of tertiary man—man's precursor. His existence can no more be denied.

WHY DO WE EAT OUR DINNER?

By Professor GRANT ALLEN.

EARLY last year a paragraph went the round of the papers to the effect that a large female anaconda-snake, in the reptile-house at the Zoölogical Gardens, after a fast of a twelvemonth, had at length been induced to kill and swallow a duck. This very touchy and vindictive lady, it appears, had taken such grave offense at her capture in her South American home, and at her subsequent compulsory voyage to Great Britain, that she sulked persistently for a whole year, and invariably refused the keeper's most tempting offers of live rabbits or plump young pigeons. Month after month she lay passive in her cage, with her heart beating, her lungs acting, and all her vital functions proceeding with the usual slow regularity of snake-life; but not a mouthful of food did she attempt to take, and not a single fresh energy did she recruit from without to keep up the working of her animal mechanism. As I read this curious case of a genuine "fasting girl" in my "Times" one morning, the thought struck me forcibly—"Why, after all, should we expect her to feed? Why should she not go on for ever without tasting a morsel? In short, why should we eat our dinner?" And I set myself to work at once to find out what was the general opinion of the unscientific public upon this important though novel question.

Singularly enough, I found that most people were content to eat their dinner in a very unreasoning and empirical way. They had al-

ways been accustomed to dine daily from their childhood upward, they felt hungry at the habitual dinner-hour, and they sat down to their five courses with an unquestioning acceptance of the necessity for feeding to prevent starvation. But when I inquired *why* people who did not eat should starve, *why* they should not imitate the thrifty anaconda, and take one meal in a twelvemonth instead of three in a day, they appeared to regard my question as rather silly, and as certainly superfluous. Yet I must confess the query seems to me both pertinent and sensible; and it may be worth while to attempt some answer here in such language as can be understanded of the people, without diving into those profound mysteries of formulæ and equations with which physicists love to becloud the subjects of their investigation.

A still more startling case than that of the anaconda will help to throw a little light upon the difficult problem which we have to solve. An Egyptian desert-snail was received at the British Museum on March 25, 1846. The animal was not known to be alive, as it had withdrawn into its shell, and the specimen was accordingly gummed, mouth downward, on to a tablet, duly labeled and dated, and left to its fate. Instead of starving, this contented gasteropod simply went to sleep in a quiet way, and never woke up again for four years. The tablet was then placed in tepid water, and the shell loosened, when the dormant snail suddenly resuscitated himself, began walking about the basin, and finally sat for his portrait, which may be seen of life-size in Mr. Woodward's "Manual of the Mollusca." Now, during those four years the snail had never eaten a mouthful of any food, yet he was quite as well and flourishing at the end of the period as he had been at its beginning.

Hence we are led to the inquiry—What is the actual function which food subserves in the human body? Why is it true that we must eat or we must die, while the snake and the snail can fast for months or years together with impunity? How do we differ from these lower animals in such a remarkable degree, when all the operations of our bodies so closely resemble theirs in general principle?

Everybody has heard it said that food is to men and animals what fuel is to a steam-engine. Everybody accepts this statement in a vague sort of way, but until the last few years nobody has been able really to explain what was the common feature of the two cases. For example, most people if asked would answer that the use of food is to warm the body, but this is really quite beside the question: because, in the first place, the use of fuel is not to warm the steam-engine, but to keep up its motion; and, in the second place, many animals are scarcely perceptibly warmer than the medium in which they live. Again, most people show in every-day conversation that they consider the main object of food to be the replacement of the *materials* of the body; whereas we shall see hereafter that its real object is the replacement of the *energies* which have been dissipated in working. Indeed, there is no more reason why the materials of an animal body should waste away

of themselves, apart from work done, than there is for a similar wasting away in the case of a mineral body such as a stone. When an animal does practically no work, as in the instance of our desert-snail, his body actually does not waste, but remains throughout just as big as ever. So we must look a good deal more closely into the problem if we want to understand it, and not rest content with vague generalities about food and fuel. Such half knowledge is really worse than no knowledge at all, because it deludes us into a specious self-deception, and makes us imagine that we comprehend what in fact we have not taken the least trouble to examine for ourselves.

Let us begin, then, by clearly realizing what is the use of fuel to the steam-engine. Obviously, you say, to set up motion. But where does the motion come from? "From the coal," answers the practical man, unhesitatingly. "Well, not exactly," says the physicist, "but from the coal and the air together." All energy or moving power, as we now know, is derived from the union of two bodies which have affinities or attractions for one another. Thus, if I wind up a clock, moved by a weight, I separate the mass of lead in the weight from the earth, for which it has the kind of affinity or attraction known as gravitation. This attraction then draws together the weight and the earth; and, in doing so, the energy I put into it is given out as motion of the clock. Similarly with coal and air: the hydrogen and carbon of the coal have affinities or attractions toward the oxygen of the air, and when I bring them together at a high temperature (of which more hereafter) they rush into one another's embrace to form carbonic acid and water, while their energy is given off as heat or motion of the surrounding bodies. We might have whole minefuls of coal at our disposal; but if we had no oxygen to unite with it, the coal would be of no more use than so much earth or stone. In ordinary life, however, the supply of oxygen is universal and abundant, while the supply of coal is limited; and so, as we have to lay in coals, while we find the oxygen laid in for us, we always quite disregard the latter factor in our fires, and speak as though the fuel were the only important element concerned. Yet one can easily imagine a state of things in which oxygen might be deficient; and in a world so constituted it would have to be regularly laid on in pipes, like gas or water, if the people wished to have any fires.

All energy, then, is derived from the separation of two or more bodies having affinities for one another. So long as the bodies remain separate, the energy is said, in the technical slang of physics, to be *potential;* as soon as the bodies unite, and the energy is manifested as motion, it is said to be *kinetic.* But these words are rather mystifying to ordinary readers, and frighten us by their bigness and their abstract sound; so I shall take the liberty of altering them for our present purpose to *dormant* and *active* respectively, which are terms quite as well adapted to express the meaning intended, and not half so likely to land us in an intellectual *cul-de-sac,* or to envelop us in a logical fog.

When we take a piece of coal and a lot of free oxygen, we possess energy in the dormant state. But though the oxygen has strong attractions for the carbon and hydrogen, they can not unite, because their atoms do not come into close contact with one another, and because the two last-named substances are bound up in the solid form of the coal. We might compare their condition to that of a weight suspended by a string, which has strong attractions toward the earth, but can not unite with it till we cut the string. Just analogous is our action when we apply a match to the coal. The heat first disintegrates or disunites little atoms of the hydrocarbons which make it up, and sets them in a state of rapid vibration among themselves. This vibration brings them into contact with the atoms of oxygen, which at once unite with them, causing a fresh development of heat, and a liberation of all the dormant energy, which immediately assumes the active form. The carbonic acid and water (or steam) thus produced fly up the chimney, carrying with them the little bits of unburned coal which we call smoke; and a current of fresh oxygen rushes in to unite with the fresh atoms of hydrogen and carbon which have been disengaged by the energy liberated from their fellows. So the process continues, till all the coal has been converted into carbonic acid and water—of course by the aid of a corresponding quantity of oxygen—and all the energy has been turned loose as heat upon the room in which we sit and upon the air outside.

In the case of an ordinary fire, where warmth is the single object we have in view, we only think of the heat, and disregard the other aspects of the process. But it is clear that an enormous amount of motion has also been set up by the energy of the free coal and oxygen, as exemplified by the draught up the chimney, and the numerous currents of air produced by its action within and without the room. Now, in a steam-engine we deliberately make use of this motion for our own purposes by a specially devised mechanism. We allow the fire to heat and expand the water in the boiler, thus transferring to its molecules the separation which formerly existed between the atoms of the coal and the oxygen. Then we make the expanded water or steam push up the piston, and we connect the piston in turn with a crank which sets in motion the wheels, and so passes on the active energy to the mill, train, or ship which we desire to move, as the case may be. Thus the dormant energy of the coals and oxygen is liberated in the active state by their union, and is finally employed to effect movement in external bodies by the intermediation of the boiler. Even then the energy does not disappear: for energy, like matter, is indestructible; but it merely passes by friction as heat to that wonderful surrounding medium which we call ether, and is dissipated into the vast void of space, no longer recoverable by us, though quite as really existent as ever.

In what way, however, has all this to do with the reason for eating our dinners? Simply this: Men and other animals may be regarded from the purely physical point of view as a kind of conscious locomo-

tive steam-engine, with whom food stands in the place of fuel, while the possible kinds of movement are infinitely more varied and specialized. I do not mean to advance any of those "automatic" theories which have been so current of late years. Whether they are true or false, they have nothing to do with our present subject. I only want to put in a plain light an accepted scientific truth. Men differ enormously from steam-engines in their possession of consciousness, wills, desires, pleasures, pains, and moral feelings; but they agree with them in the purely physical mechanism of their motor organs. A man, like a steam-engine, can not move without his appropriate fuel; and if the fuel is not supplied, the fire goes out and the man dies. The exact manner in which the materials are utilized for keeping up this vital flame is the question to which we must now address ourselves.

Food-stuffs and coal agree essentially in the chief character... of their chemical constitution. Both consist mainly of hydrogen and carbon, and both possess energy in virtue of the fact that their affinities for oxygen are not satisfied. Water contains hydrogen, and carbonic acid contains carbon; but we can get no motion out of these, because in them the oxygen has already united with the atoms for which it had affinity, and the separation necessary for dormant energy has ceased to exist. But in bread, meat, potatoes, or coal, the hydrogen and carbon remain in their free state, ready to unite with oxygen whenever the chance is presented to them. All alike obtained their energy in the same way. The rays of sunlight falling upon the leaves of their original trees or plants separated the oxygen from the water and carbonic acid in the air, and built up the free hydrocarbons in their tissues. The energy which they thus drank in has remained dormant within them ever since: in the case of the bread for a few short months, in that of the coal for countless millions of geological cycles. But, however long it may have rested in that latent form, whenever an opportunity occurs the atoms will reunite with oxygen, and the energy will once more assume the active shape. There is really only one serious difference between coal and food, and that is that most foods contain another element, nitrogen, as well as carbon and hydrogen; and this nitrogen is an absolute necessity for the animal if it is to continue living. But there are good reasons for suspecting that nitrogen is not itself a fuel, being rather analogous in its nature to a match, and having for its business to set up the first beginnings of a fire, not to keep the fire going when it has once been lighted. So that this apparent difference of kind is really seen to be unimportant when we get to the bottom of the question.

The various matters which an animal eats consist of pure food-stuffs and of useless concomitant bodies: just as coal consists of pure fuel and of the useless mineral matter known as ash. When an animal eats his dinner, the process of digestion and assimilation takes place, and has the ultimate result of separating the pure food-stuffs from the

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useless concomitants. The latter bodies are rejected at once; but the food-stuffs are taken up by his veins, incorporated with the blood (which consists of food in different degrees of combustion), and used for building up the various portions of his body. Supposing the animal were a mere growing object like a crystal, with no work to perform and no consequent waste of material, the process would stop here, and the creature would wax bigger and bigger from day to day, without any alteration in place or redistribution of assimilated matter. But the animal is essentially a locomotive machine, and the purpose for which he has taken in his food is simply that he may use it up in producing motion. For a while he stores it away in his muscles, or lays it by for future use as fat; but its ultimate destination in every instance is just as truly to be consumed for fuel as is the case with the coal in the steam-engine.

The food, however, only gives us one half of the necessary materials for the liberation of dormant energy. Oxygen is needed to give us the other half. This oxygen we take in whenever we breathe. Animals like fishes or sea-snails obtain the necessary supply from the water by means of gills; for large quantities of oxygen are held in solution by water, and the needs of such comparatively sluggish creatures are not very great. With them a little energy goes a long way. Air-breathing animals like ourselves, on the other hand, need relatively large quantities of the energy-yielding gas in order to keep up the constant movements and high temperature of their bodies. Such creatures, accordingly, take in the oxygen by great inhalations, and absorb it in their lungs, where it passes through the thin membrane of the capillaries, or very tiny blood-vessels, and so mixes freely with the blood itself. Thus we have food, supplied to the blood by the stomach, the exact analogue of the coal in the engine; and oxygen, supplied to the blood by the lungs, the exact analogue of the draught in the engine. Whenever these two substances—the hydrocarbonaceous foods and the free oxygen—reunite, they will necessarily give out heat and set up active movements.

The exact place and mode of their recombination we can not yet be said to fully understand. But even if we did, the details would be sufficiently dry and uninteresting to general readers; and we know quite enough to put the subject in a simple and comprehensible form before those who are willing to accept the broad facts without small criticism.

We may say, then, that the energies of the body are used up in two principal ways—automatically and voluntarily. The automatic activities are produced by the steady and constant oxidation of some portion of the food-stuffs in the blood and tissues. As this oxidation takes place, it sets up certain regular movements, which compose what is (very incorrectly) known as the vegetative life in animals. There are an immense number of these movements always going on within our bodies, quite apart from our knowledge or will. Such are the beating

of the heart, with the consequent propulsions of blood through the system; the expirations and inspirations of the lungs, which supply us with the oxygen for carrying on these processes; the act of digestion and assimilation; and many other minor functions of like sort. But just as in the case of the steam-engine, so in the human or animal body, the union of the oxygen with the hydrocarbons, besides producing motion, liberates heat. This heat keeps the bodies of birds, quadrupeds, and human beings, which are all very active in their automatic movements, at a much higher temperature than the surrounding medium; while reptiles, fishes, and other "cold-blooded" creatures, having much less energetic motions of the heart and lungs—which of course betokens much less oxidation of food-stuffs—have bodies comparatively little different in warmth from the air or water about them. We thus see in part why it was that the anaconda and the desert-snail could go so long without food; though we can not quite understand that question till we have examined the voluntary movements as well. It should be added that, though the latter class of actions also produce heat—as we all know when we walk about on a cold day to warm ourselves—yet the temperature induced by the automatic activities of the body alone is generally sufficient under normal circumstances to keep us comfortably warm. Thus, while we are asleep, only the actions of breathing and the beating of the heart continue; but the union of oxygen with the food-stuffs to produce these movements suffices as a rule to make bed quite hot enough for all healthy persons; and if we ever wake up cold after a good night's rest, we may be sure that our automatic activities are not what they ought to be.

The voluntary activities of the body are brought about in a slightly different manner. Directly or indirectly, they depend upon the union of oxygen and food-stuffs within the tissues of our locomotive muscles, the energy so liberated being made use of to bend or extend our bones or limbs in the particular way we desire. The muscles always contain (in a healthy and well-fed person) large quantities of such stored-up food-stuffs; and the blood supplies them from moment to moment with oxygen which may unite with the food-stuffs whenever occasion demands. But the union does not here take place regularly and constantly, as in the case of the automatic organs; it requires to be set up by an impetus specially communicated from the brain. That seat of the will is connected with the various voluntary muscles by the living telegraphic wires which we call nerves; and when the will determines that a certain muscle shall be moved, the nerves communicate the disturbance to the proper quarter, the necessary oxidation takes place, and the muscle contracts as desired. We do not quite know how the nerves and muscles perform these functions; but it is pretty certain that the nitrogen of our foods plays an active part in the process, and that, as I have already hinted, it acts in a manner somewhat analogous to that of a match. We may suppose, to put the matter in a familiar form, that

the will sends down a sort of electric spark [1] to the muscle; and that this spark, lighting up the explosive nitrogen, causes an immediate union of the oxygen with the constituents of muscle, and so produces the visible movement.

Of course, voluntary actions, like automatic ones, liberate heat; but this heat is generally somewhat in excess of what is required for comfort, especially in hot weather. Lower animals, however, which have no fires and no artificial clothing, require it more than we do to keep us warm; and even we ourselves in wintry weather always feel chilly in the morning until we have had a good brisk walk to set up oxidation, and consequently liberate enough heat to make us comfortable.

Thus all motion, in the animal as in the steam-engine, depends upon the union of oxygen with food or body-fuel. It is true that in the animal body oxygen can unite directly with carbon and hydrogen without the necessity of a high temperature, which we saw was indispensable in the case of the coal, in order to bring the two sets of atoms within the sphere of their mutual attractions. But the difference is probably due to the different condition of the hydrocarbonaceous substances within the animal body; or else, as others conjecture, to the assumption by the oxygen of that peculiar state in which it is known as ozone. At any rate, the two processes do not disagree in any essential particular, being both cases in which free substances, possessing dormant energy by virtue of their separation and their affinity for one another, unite together, and in so doing liberate their energy as heat and visible motion.

There is, however, one important distinction of detail between the mechanism of a steam-engine and the mechanism of an animal body, which gives rise to many of the mistaken notions as to the use of food which we noticed above. In the engine, we put all the coal into the furnace, and burn it there at once; while the piston, cylinder, cranks, and wheels are not composed of combustible material, but of solid iron. In the animal body, on the other hand, every muscle is at once furnace, boiler, and piston; it consists of combustible materials, which unite with oxygen in the tissues themselves, and set up motion within the muscle of which they form a portion. The case is just the same as though the joints of an engine, instead of being quite rigid, were composed of hollow India-rubber and whalebone, with iron attachments; were then filled with coal, oxygen, and water, and possessed the power of burning up these materials internally and setting up motions in the India-rubber tubings. Hence the materials in the muscles are always undergoing change. The carbon and hydrogen which have united with the oxygen are perpetually forming carbonic acid and water; and, as

[1] I am speaking quite metaphorically and popularly, and do not mean to imply adhesion to the electrical rather than to the isomeric theory of nervous conduction.

[2] I purposely simplify and omit details, so as to give the reader a graphic and comprehensive picture of the central facts. So long as essentials are not distorted, a good diagram is far better for educational purposes than an accurate facsimile.

these have lost or given up all their energy, they are naturally of no more use to the body than the similar carbonic acid and steam which fly up the draught are of use to the engine. Accordingly, they are taken up by the stream of blood as it passes, separated from the useful components of that compound liquid by an appropriate organ, and rejected from the body as of no further service.

But their place in the muscle must once more be supplied by fresh energetic materials; and these materials are brought to it by the self-same blood which removes the de-energized waste products. And now we begin to see why we must eat our dinners or starve. Every time our heart beats, every time our lungs draw in a breath, a certain amount of matter in the tissues of the muscles which produced those motions undergoes oxidation, and is carried off in the oxidized form to be cast out of the body as waste. Every new pulsation or breath requires a certain new quantity of energetic material, both as food-stuffs and as oxygen; and hence we must supply the one from the stomach and the other from the lungs if we wish to keep the mechanism going. The store of hydrocarbonaceous matters laid by in the body is generally considerable in well-fed persons; for, besides the contents of the muscles themselves, we have usually a large reserve fund in the shape of fat, ready to be utilized when occasion arises. Hence, we can get along for a very short time, if necessary, without food; because we can fall back, first upon the fat-reserve, and then upon the muscles and tissues, for energetic materials. But after a time the ceaseless beating of the heart and movement of the lungs will use up all the available matters, and the blood will cast off the oxidized product and excrete it from the body; till at last no more materials are forthcoming, the whole contents of the tissues have been oxidized and got rid of, and the heart and lungs must perforce cease to act, in which case the unhappy victim is said to have died of starvation. As regards the supply of oxygen, on the other hand, we are very much more restricted in our power of endurance; for we have no large store of this necessary for combustion laid by in our bodies, and if the supply be cut off for a single moment (as by compressing the throat or suffocating with carbonic acid) the heart and lungs must cease at once to act, and death takes place immediately. For of course death, viewed on its purely physical side, means the cessation of that set of activities which results from the union of oxygen with the food-stuffs in the body.

By this time I hope the reader can see quite clearly what is the necessity for eating his dinner. If we are to live, we must keep up the cycle of our bodily activities, and especially those two fundamental ones, the breathing of the lungs and the beating of the heart. In order to do this, we must supply the muscles employed with the two energy-yielding substances, oxygen and hydrocarbons. The supply of oxygen must be continuous; in other words, we must never for a moment leave off breathing; but the supply of hydrocarbons may be intermit-

tent, though it must be sufficient on the whole to balance waste. We must not regard the object of food, however, as being merely to build up the matter of the body; we must rather consider it as intended to recruit the energies of the body. The more active any creature is, both in its automatic and its voluntary movements, the greater will be the amount of hydrocarbons consumed or used up in its muscles, and the greater, consequently, the amount of food and oxygen which it will require to make up the loss. The tiny humming-bird will need far more food in a year than the great anaconda with which we began our discourse: because the humming-bird has a rapidly moving heart and lungs, while the cold-blooded snake respires and circulates slowly; and the humming-bird darts about perpetually at lightning-speed from flower to flower, while the snake lies coiled up motionless in its blanket from year's end to year's end, or only comes out sleepily now and then to swallow the food which will keep up its vital actions through another long and lazy fast.

The desert-snail, however, can endure much longer without food than even the anaconda, because, like so many other mollusca, it can *hibernate*. This process of hibernation consists in the inducement of a state during which the heart ceases to beat, respiration is suspended, and the animal can hardly be said to live at all. But when warmth and moisture are once more applied, the heart recommences its action, the lungs or gills quicken their movements, voluntary locomotion ensues, and the creature sets out again on the quest for food. Something analogous occurs in the case of the bear, the dormouse, and other hibernating quadrupeds; but in these instances the vital functions continue much more in their ordinary state, and are kept up by the supply of fat which is dissolved by the blood, and consumed in effecting the necessary automatic actions. The bear, which goes to sleep in the autumn as sleek and plump as a prize pig, wakes up in the spring a poor, lean wretch, with only just flesh enough to cover his bones, and carry him off in search of fresh food. The much more complicated mechanism of the higher animals requires to be kept always in action; it can not cease almost entirely, like that of the snail, and then revive again when circumstances become more favorable. Hence hibernating mammals must lay by fat during the summer to keep their principal organs at work during the long winter fast. Yet, even among human beings, cases of "trance" or "suspended animation" occasionally occur, during which the cycle of vital actions almost entirely ceases to all appearance for a considerable time, and then begins again on the application of some external or internal stimulus—which latter may be not unaptly compared to the slight shaking which we sometimes give a watch or clock to set it going when stopped by a momentary impediment. Persons recovered from drowning, in whom the cessation of action has been quite sudden and has not affected the structure of their organs, are often thus restored by the judicious use of rubbing and alcohol.

The camel presents a more interesting phenomenon in his well-known humps. These protuberances consist really of reserve-stores of fat, which the camel uses, not only for keeping up the action of his heart and lungs, but also for producing locomotion in his frequent enforced fasts among the deserts of Arabia or India. The humps dwindle away as he marches, in a manner exactly similar to that of the bear's fat during his hibernation, only of course much more rapidly, as they have so much more work to perform.

Finally, it may appear strange that the small amount of food we eat should suffice to carry our large and bulky bodies through all the varied movements of the day. But this difficulty disappears at once when we recollect how large an amount of energy can be laid by dormant in a very small piece of matter. A lump of coal no bigger than one's fist, if judiciously employed, will suffice to keep a small toy-engine at work for a considerable time. Now, our food is matter containing large amounts of dormant energy, and our bodies are engines constructed so as to utilize all the energy to the best advantage. A single gramme of beef-fat, if completely burned (that is, if every atom unites with oxygen), is capable of developing more than 9,000 heat-units; and each such heat-unit, if employed to perform mechanical work, is capable of lifting a weight of one gramme to a height of 424 metres; or, what comes to the same thing, 424 grammes to a height of one metre. Accordingly, the energy contained in one gramme of beef-fat (and the oxygen with which it unites) would be sufficient to raise the little bit of fat itself to a height of 3,816 kilometres, or about as high as from London to New York. Again, it may seem curious that the food eaten by the anaconda in South America, and stored up in its tissues, should suffice to keep up the action of its heart and lungs for so many months. But then we must remember that it performed very few other movements, most probably, during all that time; and if we think how small an amount of energy we expend in winding up an eight-day clock, and how infinitesimal a part of our dinner must have been used up in imparting to it the motion which will keep it swinging and ticking for one hundred and ninety-two hours, we can easily understand how the large amount of stored-up energy in the snake's muscles might very well serve to keep up its automatic actions for so long a time.

There are five hundred other little points which this mode of regarding our bodies at once clears up. It shows us why we are warmer after eating a meal, why cold is harder to endure when we are hungry, why we need so little food when we are lying in bed inactive, and so much when we are taking a walking tour or training for a boat-race, why cold-blooded animals eat so rarely and warm-blooded creatures so often, why we get thin when we take too little food, and why we lay on fat when we take too little exercise. But these and many other questions must be passed over in silence, or left to the reader's discrimination, lest I should make this paper tediously long. It must suffice for the

present if I have given any of my readers a more rational reason in future for eating their dinners. To be sure, Nature herself has admirably provided that even the most unscientific person should find sufficient internal conviction as to the desirability of dining without the aid of extraneous exhortation; but it is at least some comfort to know that so universal and so unreasoning a practice is not altogether an unreasonable one as well.—*Belgravia.*

THE ORIGIN OF UPLAND LAKES.

By Rev. J. CLIFTON WARD, F.G.S.

WHO has not felt a sudden and intense pleasure when, rounding the end of some mighty mountain or towering crag, the still waters of an upland lake or tarn have first met the eye? Perhaps, on approach, wild birds have started from the smooth surface and left it a little sea of shimmering gold, as the sun's light has been reflected from each tiny wavelet. The raven's croak among the overhanging cliffs, the patch of snow lying unmelted deep in a rocky fissure, the scattered sheep browsing carelessly on the few grassy slopes, while all around are masses of tumbled rock, and the light veil of cloud that ever and anon sweeps the cliff-tops and adds an air of mystery and wonder to the whole—all combine to make a scene which can not but send a thrill of pleasure and perhaps of happy awe to every heart. Instinctively one feels, if the power of expression be not present, what Nature's true poet hath so truly sung:

> . . . . How divine
> The liberty, for frail, for mortal man,
> To roam at large among unpeopled glens
> And mountainous retirements, only trod
> By devious footsteps; regions consecrate
> To oldest time! and, reckless of the storm
> That keeps the raven quiet in her nest,
> Be as a presence or a motion—one
> Among the many there.

No one can wander over rugged and beautiful mountains without being led to love and admire these calm sheets of water, which lie nestled in hollows, and are ofttimes blackened by the shadow of encircling cliffs. Love for such solitary spots soon excites our curiosity as to the origin of these miniature upland lakes. In the Cumbrian lake district they are scattered broadcast over the country in far greater numbers than most people imagine, and at a period not vastly remote their number must have been more than double what it is now. But the yearly waste of mountain-side and the matter brought down by

every stream have filled up many a mountain pool, and frequent peat-mosses mark the spot where once the waters danced in the mountain breeze. Whence these hollows? What is their origin? Do we see in them the relics of volcanic effort? Are the combs (*cwm*), coves, or corries in which they lie the vestiges of volcanic craters, as the form of many at first, perhaps, suggests? Or have we here hollows produced directly by surface action? Again, are these hollows of great depth, or are they shallow? What is their general form? Now, there is little doubt that most people, if asked to draw the form of the hollow in which the waters of a tarn now lie so placidly, would grossly exaggerate its true depth, or perhaps liken it to the basin formed by placing the two hands together, side by side, curved, with the palms uppermost. Some years since I took a number of soundings among the Cumbrian lakes and tarns, and communicated the results of my examination to the Geological Society ("Quarterly Journal of the Geological Society," vol. xxx., p. 96, and vol. xxxi., p. 152). Hold out one hand, palm uppermost, and straighten it as much as possible—the hollow in the palm is yet far too deep to represent with truth the natural rock basin. Soundings taken in lakes throughout the district all show the same thing—the basins are very shallow compared with their size and the height of the surrounding hills.

Next, let us search out the origin of these shallow basins. At the outset we distinguish two classes of action, one of which must have been at work. Either the matter formerly filling the hollow has been dug out and carried away by some agent working at the surface; *or* force from below has here sought a vent, and dispersed the matter far and wide; or, from failing support, the ground has sunk at this spot into a hollow.

First we will consider the upward or downward theory. If these numerous mountain hollows, with included tarns, be of volcanic origin, then it is clear we shall find the *signs* of a crateral hollow such as we see them in many parts of the world at the present day. There are no such signs. It is true that in many cases the surrounding rocks are of volcanic origin; but the volcanic beds, in their lie and position, show no manner of relation to the tarn-hollows; and a little study of the rocks of the district and the form of the ground clearly shows that the volcanoes which gave rise to the ashes and lavas forming many of Cumbria's highest mountains, were active, not as but yesterday, but in untold ages past. Then, as to the *downward* or *special depression* theory, when we can conceive such minute subsidences taking place at a great number of almost microscopic spots without affecting the rocks around, or leaving any evidence of a sinking away, we may admit it as possible.

If not produced by expulsion of matter outward or sinking of matter inward, these hollows must be the effect of some surface-working agent. The sea *planes* away along the coast-line, and the material goes to *fill up* ocean-hollows; therefore the sea can not be the agent,

and any force in an ocean *current* is clearly out of the question over these scattered *spots*. Streams and rivers work along lines, form ravines and gorges, but never a more or less circular basin of great size in comparison with the stream, or river; hence they can not be the agents. The atmospheric powers—rain, snow, wind, and chemical action—weather the rocks indeed, form tiny basins on almost every stone; but this is but nature's fretwork, the delicate carving around the sculptured craggy tower or spire and smooth-scooped rocky front. Yet there is one surface agent remaining, the moving glacier. Most people are familiar with the proofs of former glacial action in Cumberland and Wales—proofs as clear as are those of the former greater extension of the Swiss glaciers. Now by far the greater number of our tarns lie in true rock basins—hollows completely inclosed by rocky sides, which are, moreover, smoothed and grooved in a manner peculiar to ice-action. At the sides of many a tarn and lake you may see the ice grooves and scratches passing beneath the water, so as to leave no doubt whatever that ice has once occupied the rocky hollow. The question is, Did the ice-movement form the hollow? I believe that in most cases it did, and for these reasons: 1. The tarn lies almost invariably in the path of old ice streams or glaciers, as is proved by the direction of the scratches in the surrounding rocks. 2. They *frequently* occur at the foot of slopes more or less steep, or where the ice-pressure can be shown to have been great. 3. The position of the deepest points in the larger tarns and lakes occurs almost invariably where, from the confluence of two or more glaciers or the narrowing of the valley, the ice-pressure must have been somewhat increased. 4. The depth of these tarns is very slight as compared with the thickness of the ice which can be proved to have passed over them. 5. There is every gradation from a tiny, rock-bound pool, glaciated on all sides, and which all will admit must have been scooped out by the ice, to the tarn or lake showing precisely similar phenomena on a larger scale.

Since the ice-plow passed over our land the atmospheric powers have been at work for a long period; and while many rock basins are now completely filled up by stream-borne matter, all are *being* so filled, and each age must witness a decrease in the number and size of those sheets of water which form so marked a character of our Cumbrian scenery.

Before quitting this subject, however, I must remark that there are a few tarns which seem to me to owe the whole or a part of their depth to a moraine dam. That is to say, the rock basin is imperfect on one side, and there an old glacial moraine may have helped to dam the waters back ever since the retreat of the glacier which threw off the moraine. It frequently happens that a little moraine material has been left upon ice-rounded rocks at the foot of a tarn, and in such cases a hasty observation might lead one to believe that the whole

mound was a moraine. Let us remember, then, that a tarn may lie in a complete rock basin, ice-formed; in a glaciated hollow dammed on the lower side by a moraine or other accumulation of rocky *débris;* or it may owe part of its depth to a rock-inclosed hollow, and part to a morainic dam. Therefore, on a summer's day, as we lie dreamily gazing upon the rippling waters of these mountain tarns, we may sometimes think of an age which is past, when the ice-sheet moved majestically over the now heather-clad fells, and all the country lay "clad in white samite, mystic, wonderful."—*Popular Science Review.*

SKETCH OF SIR HUMPHRY DAVY.

HUMPHRY DAVY, one of the world's greatest chemists, and the discoverer of the electric light, was born December 17, 1778, at Penzance, in Cornwall. His father, a wood-carver and gilder by trade, died in 1794, leaving his widow and five children, the oldest of whom was Humphry, in destitute circumstances.

Humphry was a strong, active, healthy child, and gifted with a singularly retentive memory. Sent to an elementary school at the age of six, he made such rapid progress that soon the master had him transferred to the town grammar-school. In his boyhood he manifested a strong liking for open-air sports—riding, fishing, shooting, and the like—also for making collections of natural-history specimens. This bias was anything but pleasing to his teachers and guardians, who feared that, unless he gave more time and attention to his book-lessons, he would grow up to be a ne'er-do-well. Fishing was his favorite amusement. When a little child he was to be seen after every rain—and rains are exceptionally frequent at Penzance—fishing in the street-gutters. At nine years of age he went to live in the household of a Mr. Tonkin, a friend of his mother's family, resident at Varfell, a little village in Mount's Bay. The site of Varfell is a charming one, and the surrounding country is rich in minerals. Young Davy, who was of a poetic temperament, was at home in this delightful nook, and what with his shooting, fishing, and collecting, his days were full of enjoyment. Evidently he loved nature rather than books, and though his guardian feared that his studies—if study that may be called which was all play—were taking a wrong direction, he was in reality acquiring the rudiments of a very solid education—acquaintance with nature's ways. The little child who fished in the gutters of Penzance later wrote that charming work, "Salmonia, or Days of Fly-Fishing," wherein, mingled with notes of his piscatorial exploits in the trout-streams of the Austrian Alps, are philosophical reflections on the deepest problems of the universe. As a boy he loved to roam among the hills of his native

Cornwall; in the fullness of his fame he was passionately fond of traveling, and his latest book was "Consolations of Travel"—the work of a dying Plato, as it was called by Cuvier.

On the death of his father, Davy, who was then just entering on his sixteenth year, was apprenticed to Mr. Borlase, apothecary and surgeon of Penzance. He now resolved to begin a systematic course of study, literary and scientific. In his boyish ardor, the task he set himself was nothing less than the acquisition of universal knowledge. His MSS. of this period contain the germs of many of the thoughts which found more perfect expression in his maturer writings. In his note-books, a voluminous collection of which he left behind him, he was accustomed to make a record of every chance observation, and of every more important thought which occurred to his mind. Says a writer in the "Chemical News," to whom we are indebted for many of the particulars of Davy's career contained in the present sketch: "Observations of every kind and sort are included in these pages. At one time he notes down a peculiarity of flight in a swallow, at another a philosophical or theological puzzle, at another the anomalous behavior of certain reagents, with a view to further investigation; whatever, in fact, he observes, down it goes for future reference or consideration."

In 1796 he read Lavoisier's "Elements of Chemistry," and so was led to the experimental study of that science, in which later he attained the highest eminence. The following year he began to write his "Researches on Light and Heat," published in 1799. One of his first chemical researches had for its object to determine the nature of the air which fills the vesicles of common sea-weed; and he demonstrated that the marine plants act upon the air precisely in the same way as the terrestrial, by decomposing carbonic acid under the influence of the sun's rays. These physical and chemical researches won for him in 1798 an invitation from Dr. Beddoes, director of the "Pneumatic Institution" at Clifton—a sort of hospital for the treatment of pulmonary diseases by the inhalation of different gases—to become his assistant. Having removed to Clifton, Davy made use of the facilities which the Pneumatic Institution afforded for studying the physiological effects of various gases—as nitrous oxide (laughing-gas), carbonic acid, nitrogen, etc. These experiments more than once came very near being fatal to the venturesome young chemist, and indeed his health was seriously impaired, so that he was forced for a time to intermit his researches. While at Clifton he also took up the subject of galvanism, and thus laid the foundations for his brilliant discoveries in electro-chemistry.

In 1801 Count Rumford offered him the position of lecturer on chemistry in the London Royal Institution, which he had recently founded. This post he held for one year, and then was formally appointed Professor of Chemistry in the same institution. Davy was a remarkably handsome man, of good stature, gifted with great eloquence, and above all an enthusiast. His lectures at once became the

talk of the town, and the highest ranks of society began to throng the theatre of the Royal Institution whenever Davy was announced to give a lecture. He was, as the saying goes, the lion of the metropolis, and was carried away by the tide of fashionable life. During the hours of the day he attended to his duties at the Royal Institution, and pursued his scientific researches with the same ardor as ever, but he "devoted the evening to social intercourse with the aristocracy of birth and brain, with all the thoroughness of his nature."

In 1802–'3 he delivered a course of lectures on agricultural chemistry. These lectures were afterward published under the title of "Elements of Agricultural Chemistry," and the work passed through many editions at home, besides being translated into almost every language of Europe. His observations on the chemistry of tanning were published in 1803 in the "Philosophical Transactions." His researches on electro-chemistry, begun at Clifton, were continued at the Royal Institution. His two famous "Bakerian Lectures," the first on the laws of electricity in relation to chemical combination, and the second on the results of the application of these laws, were delivered in 1806 and 1807 respectively. He discovered the base potassium October 6, 1807; sodium and other bases soon afterward. We are told that "when he saw the globules of potassium appear and take fire as they entered the air, his delight was so great that for some time he could not compose himself sufficiently to continue the experiment." Indeed, his mental labor and the excitement over his discoveries had such an effect on his general constitution, that for several weeks he lay seriously ill. On his recovery he presented to the Royal Institution the battery of two thousand cells with which he had made these great discoveries. It was with this battery that, in 1813, he produced for the first time the electric light. When the current from this pile was passed between two pointed pieces of wood charcoal, attached to conducting wires, a light was produced of such dazzling brilliancy as to be comparable only with sunlight. The length of this electric arc was four inches.

In 1803 he was elected a Fellow of the London Royal Society. He was knighted in 1812, and the same year married a wealthy widow, Mrs. Apreece. His "Elements of Chemical Philosophy" were published this year. He now resigned his professorship at the Royal Institution, and in the following year visited the Continent of Europe. At Paris he was received with distinguished honor by the Academy of Sciences, and demonstrated to that august body that iodine is an element. He remained abroad some two years, in the mean time diligently pursuing his chemical researches. At Florence he investigated the nature of the diamond, which he proved to be an allotropic form of carbon. His researches on colors and on the iodine compounds were also carried on during this period.

In 1815 he made the tour of Scotland, and on his homeward journey visited the coal districts of England. A committee of colliery proprie-

tors waited on him to induce him to study the causes of the numerous explosions of fire-damp which were annually attended with fearful loss of life. He began his investigation by analyzing the gas and ascertaining in what proportions its mixture with air renders it most explosive. Having observed that the combustion was not communicated through tubes of small dimensions, he gradually reduced the length of the tubes till he found that a simple metallic gauze, with spaces not exceeding $\frac{1}{21}$ of an inch square, was sufficient to prevent the burning gas on the one side from igniting the explosive mixture on the other. On this principle he constructed his "safety-lamp."

At the recent celebration of the centenary of Davy's birth, held at his native town of Penzance, it was remarked by one of the orators, a colliery proprietor, that but for the discovery of Davy's lamp some of the best seams of coal in England would have remained unworked, or could only have been worked at such cost that none but the rich could afford to use coal. "Davy's lamp," he further said, "is still the best, and if properly constructed, and used in conjunction with efficient ventilation, is an infallible guide to the presence of dangerous gases."

Urged to have his lamp patented, Davy made this noble reply: "My sole object was to serve the cause of humanity; and if I have succeeded I am amply rewarded in the gratifying reflection of having done so." In 1817 the colliery owners and miners of England presented Davy with a magnificent service of plate worth £2,500. This was bequeathed to the Royal Society by Lady Davy, who directed it to be sold and the proceeds applied to the encouragement of science.

In 1818 Davy was created a baronet. The same year he again visited the Continent, traveling extensively in Germany, Hungary, and Italy. The possibility of unrolling the Herculanean papyri engaged his attention while in Naples, and he published observations on volcanic phenomena, and on Oersted's electro-magnetic experiments. He was elected President of the Royal Society in 1820, and held that office for seven years. In 1823 he succeeded in devising a method of preventing the corrosion of the copper sheathing on ships' bottoms.

He now fell into ill health, and but little scientific work was done during the remaining years of his life. Three or four times he visited the Continent, but received little benefit from the change of scene and of climate. He died at Geneva, May 29, 1829, and there, in accordance with his own wishes, was buried. His widow founded a prize in his honor, to be awarded biennially by the Geneva Academy of Sciences for "the most original and important discovery in chemistry."

EDITOR'S TABLE.

SCIENCE IN RELATION TO WAR.

HOW the art of war, by the powerful stimulus it has given to the investigation of the properties of projectiles and numerous kindred researches, has been an efficient promoter of progress in physical science, is well understood. The strife among engineers to construct guns that shall be able to pierce any barrier, and to construct barriers that shall resist all guns, has led to results in improving the quality of metals which could hardly have been gained in any other way.

It is not, however, this aspect of the science of war that here interests us; but rather its ethical side, or the excuses that can be offered for it as a part of the policy of Nature. An English writer* has recently gone into the subject, and attempted a scientific defense of the general and permanent habit of war which it is important to notice, in order that science may not be perverted to false and injurious ends.

The writer with whose views we are now concerned points out in an interesting manner in what way science has operated to alleviate the horrors of war, to shorten its duration, and temper its effects. He remarks that in the days of the old smooth-bore, when it was a maxim not to fire till the whites of the opponents' eyes were visible, it was said to take a man's weight in lead and iron to kill him, so many bullets and cannon-balls were fired ineffectually; but now, owing to the increased distance at which firing takes place and to the general use of earthworks, it is still more difficult to do execution. The statistics given by the writer strongly corroborate this view. He says the average number of killed and wounded on both sides in the great Napoleonic battles taken collectively was a little over one fourth of the whole forces engaged; while the average in the great European battles fought within the last thirty years, since the general introduction of arms of precision, gives a little less than one twelfth. We are also reminded that the more improved modern warfare engenders less hatred between the conflicting parties. "Before the invention of gunpowder, when fighting was conducted at comparatively close quarters, soldiers fought with an animosity which is now rarely seen. The man who was to take your life unless you took his, projected himself before you dangerous and hateful, but under the present system wounds seem to come from some impersonal agency; a man is less vividly impressed with the personality of his foe, who, like the Ethiopians, is blameless because he is far away, and whose individuality is lost at the distance of a quarter of a mile, where he is taking shots at you from behind a hedge. But in ancient times great bodies of men once interlocked in conflict could not be drawn off till utterly exhausted with mutual slaughter, and hence we read of such battles as Cannæ, where on the Roman side alone, according to Polybius, out of 86,000 men not much more than 15,000 prisoners or fugitives came off unhurt; and Cressy, where there perished of the French on the field or in the pursuit between 30,000 and 40,000 men—battles in which the wounded and disabled experienced in butchery that cruelty to which in brave minds the frenzied fears attending close conflict can alone give rise."

Our new philosopher of war is quite ready to concede its evils, its calamities, and its horrors—its terrible waste of

* "The Philosophy of War," by James Ram.

treasure, blood, and life. He says millions of men all over Europe are at this moment idling away their time in demoralizing barrack-life, trained among much physical and mental deprivation to no art but that of destroying each other skillfully, which is much as if they had been usefully employed and the products of their labor then cast into the sea. We are reminded of the immense amount of work bestowed upon a first-class ironclad, which is liable to be sent to the bottom in an instant. She may have cost $2,000,000 and her equipment another half million; so that if the ordinary laboring man earns $250 a year, on the average of twenty years of working life we have the whole life's labor of 500 men destroyed by the single loss of such a ship. Blood and health are precious; war spills the former and impairs and destroys the latter on an appalling scale. As to the waste of life, it is of course incalculable; yet, if there be a money estimate of it, the result is shocking. Laboring men are capital in society, and it is a very moderate estimate to assume them from this point of view as worth $2,500 a piece. A battle, therefore, in which 20,000 men are killed, annihilates $50,000,000 of capital in human beings alone.

The sufferings of war are conceded to be indescribable. Mr. Ram remarks: "Of all incidents of battle the one which impresses itself most strongly on my imagination is that of Borodino, where 60,000 French and Russians were left upon the ground; the groans of the wounded in the ensuing night sounded at a distance like the roar of the sea. The far-off listener might expect to hear outcries of pain and distress from such a scene, that screams of agony should arise from instant to instant, and that the doleful, piercing note should be taken up from this point and from that, and that night should be made hideous by this inarticulate misery. But here was no such intermittent lamentation. From amid 20,000 corpses arose a hoarse, uniform, unceasing roll of the anguish of 40,000 men!"

How, then, are we to regard these practices? Our author says that we must turn to Nature to find how she regards such things. Is war an exception to her course, or does she regard men fighting as a naturalist looks on tribes of ants destroying each other? The answer is, that Nature is absolutely pitiless. Her eyes never fill with tears. She multiplies to destroy, and destroys without mercy.

"Her taller trees debar the meaner shrubs from sun and breeze. It is nothing to her that the more lowly plants in the forest wither and pine for light and air. It is her will that the weakest should go to the wall. Ravin is the condition of the existence of half her creatures; and at this moment, as all around this sea-girt ball the strong animals prey upon the weak for their daily sustenance, more skins are being pierced and torn, more bones being crushed, more blood being shed, in the far-off places of the earth than twenty Russo-Turkish wars going on together would involve. Are we to be told that Nature enjoins these things, and yet is outraged by men tearing and rending each other? Still she is not simply indifferent. She appears to have a purpose in all this. She knows that the world is not rich enough for all. She keeps it upon principle in a condition of over-population. She thinks it better that the strong should crowd out the weak than that the weak should crowd out the strong by mere dint of numbers under any protective system. She seems to desire the greatest good possible in the world, and her means to this end is the selection of the fittest, with the extermination of the less fit; the selection of the most highly organized in body, which includes the most highly organized in mind. In her care for the type she disregards individual men and individual races.

"The excellence of man himself is

the outcome of continual fighting among species of anthropoid animals involving the continual destruction of the weaker by the stronger and the constant selection of the fittest to survive. It is curious to note that it is not those most distantly below us in the scale that we are chiefly eager to destroy. It is generally those who more nearly approach to us in gradation and who consequently clash with us, that we destroy. Those whose complete inferiority prevents us from fearing them escape. At the present time, Nature is doing much more by human agency to destroy Red Indians and native Australians than to exterminate gorillas. No links have so great a tendency to disappear altogether as those which are nearest to ourselves in the chain. As man ascends the ladder he kicks off those who stand on the next step below him. This habit has in time created an immense gap between us and some of those through whose condition our race has once passed—a gap so wide as to make it almost impossible for any but studious men to realize that there is indeed any solidarity between us and the lowly forefathers ascribed to our species."

There is much truth, no doubt, in this view of the operations of Nature, but it is far from the whole truth as relates to the morality of war. It certainly will not do to excuse private violence and offer a defense of crime on the ground that Nature is also ruthless and violent. And if individuals may not plead the example of Nature to justify their injurious interference with others, neither may nations. That war was indispensable in the lower stages of society when brute force predominated, and became a means of enforcing those subordinations which led to social order, may be freely admitted. But if old practices are to go on for ever, what becomes of progress? The essence of evolution is transformation—the substitution of higher agencies for lower in the unfolding economy of the world. War is one of the things that must certainly be left behind if there is to be any advancing or upward movement. It is the old and deadly enemy of the pacific and constructive forces of society, which have nevertheless made way against it, and which may be expected in the future to gather a strength that will redeem society from the baneful influence of the military spirit.

AN HISTORIAN'S NOTION OF LINGUAL STUDY.

We referred last month to the revival of the old classical controversy consequent upon the proposal to drop compulsory Greek from the curriculum of the University of Cambridge, in England. The controversy grows warm in various quarters. Mr. Freeman, the historian, comes forward in the "Fortnightly Review" to discuss the question, "Shall we give up Greek?" and uses the occasion to go into the general subject. He regards the present spasm of controversy as not very serious, inasmuch as he has had experience of such things before, and thinks it is merely part of a system of curious intellectual cycles, the causes of which would perhaps form fit subject for the philosophical statistician. Mr. Freeman says there was a sharp brush over the question in 1871, in which he took a part, and that we are now engaged in merely reproducing the old arguments and the old answers.

But Mr. Freeman betrays, in his treatment of the subject, the consciousness that it is advancing, and that these rhythmic disputes are bringing about very serious changes of opinion. He pleads strongly for Greek, but seems to feel that it is doomed, and is decided in his conviction that, if but one of the classical tongues is to be retained, it must be Latin.

His general position in relation to the question is much the same as that so elaborately put forth by John Stuart

Mill in his celebrated St. Andrew's discourse; in both cases we are presented with a grand picture of the intellectual advantages derivable from the acquisition of many languages, and their comprehensive philosophical study. Against this, as we have often said, there is, in itself, nothing to urge. It is an entirely proper thing for men of capacity, whose tastes lead them in this direction, to give their lives to linguistic philosophy, and the acquirement of many languages. But, for ordinary students in college, this is simply futile and impossible, and we have here the perpetual fallacy of the advocates of classical studies. Experience in the universities of all countries and for centuries, and everywhere attested to-day, assures us that this ideal classical accomplishment is not attained, nor anything approaching it. Mr. Freeman says: "If Greek and Latin study could never come to anything more than that kind of scholarship which in its highest form corrected the text of a Greek play and made Greek iambics and Latin elegiacs—which in its lowest form turned out that fearful form of bore which is ready at every moment with a small scrap of Horace or Virgil—if this is all that comes of Greek and Latin study, we might be tempted to say, Perish Greek and Latin study!" But what else do we get, or can we get, but that sort of scholarship from the great mass of students in colleges? He thinks that teaching can be improved so as to yield better results, but that has been the illusion of hundreds of years. The failure and defeat of classical studies has been the opprobrium of the universities for generations, and from the time of Milton to the present there have been loud calls for reform and improvement in the modes of classical instruction; but the changes have not come, and the old results continue, nor is any such reform possible. The vice of our system of higher studies is the enormous disproportion between the study of language and the period allowed for education, or even the common length of life. Mr. Freeman says: "I believe, then, that if we can only learn all tongues in a rational way, we may keep our Greek and our Latin, and bring in our German, our French, our Italian, above all our English, in their due places alongside of them." Two results must ever follow from the attempt to realize any such ideas in practice: First, such a predominance of lingual study must effectually exclude all other most important subjects from the curriculum; and, second, the acquisition of the languages themselves will generally be so miserably imperfect that the higher ends aimed at will not be reached. At the foundation this acquisition of languages is a problem of cerebral dynamics. The learning of a language exhausts a very considerable portion of the plastic power of the brain. The acquisition of six languages is, of course, a still more enormous draft upon the cerebral energy, and there must be very considerable native capacity if so many forms of speech are *thoroughly* acquired so as to be brought into relations of critical comparison for philological purposes. Not one student in twenty, nor indeed one in a hundred, will ever do this, and the great mass of them will fall so lamentably short of it that the time given to the study is essentially wasted. Let languages, ancient and modern, living and dead, be pursued to any extent by those who are drawn to the study and propose to devote themselves to this line of scholarship. What we protest against, and what the common sense of the age undoubtedly condemns, is this tenacious and self-defeating ascendancy of extinct languages in the higher education of our youth at large.

We say "extinct" languages, but Mr. Freeman does not like this idea at all. He objects to regarding Greek and Latin as "dead, ancient, classical." He would abolish the current distinction

between antiquated and recent—the living and the dead. He says, "I claim for the Greek tongue its place on the exactly opposite ground—because it is not dead but living, because if it is ancient, it is mediæval and modern no less." This is a new argument for the so-called ancient and dead languages that they are not as ordinarily characterized, but are in reality living and modern. And what else is it but the nonsensical makeshift of a hard-pushed advocate? If the Greek and Latin tongues are still living, why not the Greek and Latin nations? If these languages are not ancient, is there anything ancient? The course of nature goes on, and materials of all kinds are used over and over again in unbroken continuity, but because the present is thus born of the past, are we to forget the distinction between the living and the dead. If the ancient languages are modern, then of course ancient history, and ancient philosophy, and ancient art, are modern history, modern philosophy, and modern art, and there is no end to the stupid confusion. We can hardly congratulate Mr. Freeman on his defense of the cause he has espoused, and have referred to it merely as illustrating the best that can be said by a distinguished historical writer in defense of old academical superstitions.

LITERARY NOTICES.

JOURNAL OF A TOUR IN MAROCCO AND THE GREAT ATLAS. By JOSEPH DALTON HOOKER, K. C. S. I., C. B., Pres. R. S., Director of the Royal Gardens, Kew, etc.; and JOHN BALL, F. R. S., M. R. I. A., etc., with an Appendix including a Sketch of the Geology of Marocco, by GEORGE MAW, F. L. S., F. G. S. Macmillan & Co. 1878. Pp. 489. Price, $6.50. Illustrated.

THE territory of Marocco, which is larger than Spain, and is within six days' sail of England, extends along the Mediterranean from Algeria through the straits of Gibraltar to the Atlantic Ocean, and southward to nearly opposite the Canary Islands, having a coast-line of fully nine hundred miles. Although so near to Europe, this country, beyond its coast, is among the least known regions of the earth; but it is supposed to reach far into the Great Desert on the southern side of the Great Atlas range. It has been called the China of the West, but it is even more isolated and impenetrable than China itself. This scientific expedition to Marocco was undertaken at the beginning of April, 1871, and lasted till the middle of June, but for various reasons the account of it was not published till 1878. Delay of publication, however, can make no difference in the case of Marocco, where it seems there has been little change during the last two centuries. For a long time Sir Joseph D. Hooker had wished to explore the range of the Great Atlas, to learn whether its vegetation furnished connecting links between that of the Mediterranean and the peculiar flora of the Canary Islands. Maw had already made collections of living plants along the coast of Marocco, and had pushed farther into the interior than any but one preceding traveler, and Ball had visited the country in 1851, but its disturbed state made all exploration impossible. Now, however, through the intervention of the Foreign Office, the Sultan of Marocco gave permission for the visit of these distinguished travelers, and on the 7th of April they reached Tangier, one of the most important towns of Marocco, thirty-five miles from Gibraltar, on the coast of the Mediterranean. It is the residence of the diplomatic agents sent from other countries, and consequently the Moorish authorities are somewhat under the control of civilized opinion, and life and property are tolerably secure. Its neighborhood is the only part of all Marocco where a naturalist can wander without an escort of soldiers, and hence little was known of the flora of the empire, except collections from the Djebel Kebir or Great Mountain just west of Tangier. Before going to south Marocco, it was needful for their safety and success that the travelers should have an autograph letter from the Sultan, to prevent the local authorities from defeating their purpose. They had to wait several days for this document, and spent the interval in exploring the Lesser Atlas, with results of ex-

ceeding interest, which are set forth in the second chapter of the work. The Sultan's letter at length arrived. It was written "on a small sheet of inferior paper, folded to the size of a note, and sealed with coarse sealing-wax." It was addressed to the Governor of Mogador, and ran thus: "On receiving this, you will send the English *hakeem* and his companions to the care of my slave, El Gradui, to whom I have sent orders what to do." This slave was the Governor of that portion of the Great Atlas which it was desired to explore. They started at once for south Marocco, and reached the port of Mogador on the 26th. Thanks to the Sultan's letter, the Governor provided for their safety and comfort during their journey across the plains from Mogador to Marocco. They had time to study the region about Mogador, and their observations, meteorological, geographical, zoölogical, and ethnological, as well as botanical, are recorded in Chapter IV. Chapters V. and VI. narrate the journey from Mogador to Marocco. The six following chapters are devoted to the exploration of the Great Atlas. Chapter XIII. describes their second stay at Mogador, their return to Tangier and England, and Chapter XIV. discusses the future prospects of Marocco. The narrative from first to last is one of absorbing interest, not only to botanists but to readers of all classes. The maps and pictures add greatly to the interest and value of the work. It is scarcely possible in the space at our disposal to give any fair idea of the work by means of extracts. The great ability and experience of the authors are evident not only in the delightful and instructive account of each day's proceedings, but equally in the reflections scattered throughout the volume upon numerous subjects, suggested by the physical, social, and political aspects of this strange country. For instance, in speaking of the climate of north Marocco, we have the following:

> Nothing is more rare than to find a country where neither the natives nor foreign visitors have any complaint to make against the climate, and in this respect Marocco is almost unique. As regards the season of our visit, however, our case was that of nearly all travelers in whatever country they may find themselves. We had arrived in an exceptional season! How often is this fact gravely stated as something remarkable and unusual in the experience of the narrator, whereas, if he would but reflect, it merely represents the common experience of mankind in most countries of the earth! Excepting some portions of the equatorial zone, where the seasons recur with tolerable constancy, our notions of the climate of a place are got at by taking an average among a great many successive seasons. Any one who watches the meteorological notices, published in our newspapers, must be aware that if any particular day, week, or month be compared with the general average for the same period during a long term of years, he will find it considerably hotter, or colder, or drier, or moister, than the corresponding average day, week, or month; and, when registers have been kept for a sufficient time in other countries, the same result will be seen to hold good. Travelers will then be prepared to find that they should expect to enjoy, or suffer from, an exceptional season, and will think it more remarkable when they happen to alight on a season near to the average.

We also note the following hint to travelers:

> The net result of our short excursion was not large or brilliant; but, in the case of a country so little known as Marocco, the interest of his collections to a naturalist does not mainly depend on the rarity or novelty of the objects he may happen to meet. Each plant or animal carried away contributes an item of information respecting the distribution of the organized world, the value of which it is impossible at the time to estimate. Travelers who happen to visit little-known countries would do well to remember that with the most trifling trouble they may make useful contributions to natural science, by preserving specimens of the most insignificant-looking objects, provided always that these are afterward placed in the hands of competent naturalists.

INTERNATIONAL SCIENTIFIC SERIES, No. XXV. EDUCATION AS A SCIENCE. By ALEXANDER BAIN, LL. D., Professor of Logic in the University of Aberdeen. New York: D. Appleton & Co. Pp. 453. Price, $1.75.

IN the maturity of his studies as an original investigator of the science of mind, and in the ripeness of his experience as a practical teacher in the higher sphere, Professor Bain has suspended the course of his customary work to prepare a little treatise on education, and we have no doubt that, as it is the latest, so it will be regarded as the best and most valuable, of his books. Less formidable than his elaborate volumes on "The Senses and the Intellect" and "The Emotions and the Will," the new book is still very full, and brings us to the more important application of the views contained

in these works. In so far as education depends upon principles, it is capable of being dealt with as a science; and, though a practical art, yet like all other arts it must be pursued by blind habit or under rational guidance. We have pointed out again and again in this "Monthly" how the science of mind has been widened in modern times so as to include its corporeal conditions, and thus bring the living being into view as a psychical organism rather than the mere abstraction of mind. This is the method of the modern psychology, the immense superiority of which over the old mental philosophy is most apparent in the field of education. We know nothing of mind except as manifested through its organic machinery. When we consider mind as mental force, it at once becomes complicated with the bodily energies, and it appears under limited and quantitative laws, which it should be the first task of the teacher to master. Mind and body are developed together, and the former can not be intelligently *led out* except under inflexible corporeal restrictions. Professor Bain's long familiarity with this point of view has specially and eminently qualified him to prepare a practical manual of school culture that treats educational questions in detail in harmony with the present state of knowledge.

It is impossible to give anything like an adequate analysis of this admirable work within the limits of an ordinary literary notice, nor, indeed, is it necessary. Portions of it have already appeared from time to time in this magazine, by which our readers have been somewhat informed of its scope and object. Yet the articles published fail to convey any just idea of the adaptation of the book to the needs of those engaged in the work of practical instruction. Certain important psychological considerations of a general nature were brought forward in a way to illustrate their grave significance, but little, however, was said of their bearing on the exigencies of school-work. In the volume these expositions are recast and thrown into such a shape that their applications and bearings are brought out in their full force. The various current studies in our schools are taken up systematically, with the view of determining their educational power, and how they stand related to the unfolding of the mental faculties. This is a most important portion of the work, one hitherto greatly neglected by educators, and the conclusions of which require to be sharply brought out and vigorously enforced. The waste of exertion on worthless objects of study in our schools is something frightful —objects of trifling worth alike in the information they give and in the narrow and imperfect mental discipline they afford. In regard to the study of languages especially, Professor Bain's views are entitled to the most serious attention. The study of language, its critical and careful study, Professor Bain of course recognizes to be of the first importance; but, at the same time, he maintains that the educating power of language is enormously over-estimated. That which is but a preliminary use of tools, indispensable in itself, but utterly subordinate to the larger objects beyond, to which it is but a means and a stepping-stone, has been exalted into the great end, and almost the whole time of education is thus wasted upon initial acquisitions. Professor Bain denies that the study of language, however extended, can educate in any real or adequate sense. After considering this subject, and laying down the principles that should guide its study, and the practice of lingual exercises, he passes, in Chapter X., to the formal consideration of the value of the classics. With this gigantic superstition he makes no terms. The pretexts for its continued ascendancy are successively and effectually exploded. Without denying that some small benefit may of course arise from the study of dead languages, as hitherto and commonly pursued, he demonstrates the utter futility of the several claims put forward in their behalf, and shows how, by standing in the way of modern studies, the classics are a fatal hindrance to that broad and thorough mental discipline which can only be acquired by a larger exercise of the mind in scientific methods, and upon the knowledge of actual things.

An important phase of the work is the treatment of what Professor Bain calls the logical or analytical problem of education. It involves the question of the sequence of

subjects in the various schemes of study, both in relation to the order of the unfolding faculties and with reference to the logical dependence of the subjects themselves. The art of teaching, its various methods, and the principles that should guide them, involving a discussion of the philosophy of object-lessons, are prominently dealt with. Moral education receives passing attention, and Professor Bain suggests various changes which the present system must sooner or later undergo, in a chapter on the higher studies in the curriculum of the future. The author says: "The general strain of the work is a war not so much against error as against confusion. The methods of education have already made much progress, and it were vain to look forward to some single discovery that could change our whole system. Yet I believe that improvements remain to be effected. I take every opportunity of urging that the division of labor in the shape of disjoining incongruous exercises is a chief requisite in any attempt to remodel the teaching art."

We recommend this book emphatically to all teachers, parents, superintendents, and school trustees, who have any serious interest in the improvement of education, and can prize efficient and intelligent help in carrying on their work.

DEMONOLOGY AND DEVIL-LORE. By DANIEL MONCURE CONWAY, M. A. With numerous Illustrations. New York: Henry Holt & Co. 1879. 2 vols. Pp. 444 and 484. Price, $7.

MR. CONWAY'S studies in demonology were begun many years ago, and in 1859 he published in the series known as "Tracts for To-day" (Cincinnati) an essay entitled "Natural History of the Devil." The very title of that tract was evidence that its author had in his hand the one clew which could conduct him surely through the mazes of the weird and fantastic demon-world. Monstrous and unearthly as the forms of that strange world may appear, they were every one the product of the normal operations of man's mind, as modified by its internal and external conditions, and they can be explained and understood only by tracing them to that source—in other words, by developing their *natural history*. But twenty years ago the idea that demons and devils have a natural history was not so obvious a one as it is to-day; and our author, in giving that title to his essay, approved himself to be a bold and original thinker. Nevertheless, as he confesses in the preface to the work before us, he had then no adequate conception of the vastness of the domain which he attempted to survey. But reading and observation in foreign countries have since given him at once larger and clearer views of that phantasmal world of which, as a denizen of the North American Continent, he had only heard a rumor, so to speak. True, being a native of Virginia, and bred on a plantation, Mr. Conway enjoyed the advantage of observing the phases of demonism in the negro mind; but, for all that, it was only after he had visited in Europe the haunts of the ancient chimeras, goblins, and demons, and made himself familiar with the traditions current among the lower orders of the population, that he could realize the all-pervading force of this superstition.

In the present work Mr. Conway sets forth the results of his protracted researches. The amount of material he has accumulated is enormous, and yet he has by no means exhausted the subject. He aptly likens his effort to "Thor's attempt to drink up a small spring, and his failure because it was *fed by the ocean*." It would be labor in vain for any one man to attempt a full account of the world of demons and devils —a world as diversified and as vast as the physical world around us—and our author has wisely restricted himself to giving illustrations of its leading typical forms. Like another Linné he groups in genera and species, so to speak, these creatures of phantasy, and thus out of direst confusion evolves order and system. Hence his work is valuable, both as a repertory of out-of-the-way information and as an essay in psychological analysis.

It is impossible to give within the limits of a notice like this even an outline of the author's argument, and therefore we will simply call attention to a few of the noteworthy points developed in the work. And first we find a distinction drawn between "demon" and "devil." Demons are beings whose harmfulness is not gratuitous,

but incidental to their own gratifications; a devil loves evil for its own sake. Sometimes a god belonging to a conquered tribe is degraded to the rank of a demon in the mythology of the conquerors. Again, there are demons (or, as the case may be, devils) created by pure accident! "Belial" is an instance of this, being an erroneous personification of "godlessness." The author's remarks on demonism in India are *à propos*: "The Hindoos have covered their land with temples to propitiate and deprecate the demons, and to invoke the deities against . . . drought and famine. Had they concluded that famine was the result of inexactly quartered sun-dials, the land would have been covered with perfect sun-dials; but the famine would have been more destructive, because of the increasing withdrawal of mind and energy from the true cause, and its implied answer. But how much wiser are we of Christendom than the Hindoos? They have adapted their country perfectly for propitiation of famine-demons that do not exist, *at a cost which would long ago have rendered them secure from the famine forces that do exist.* We have similarly covered Christendom, . . . while around our churches, chapels, cathedrals, are the actually existent seething hells of pauperism, shame, and crime." Demonism still subsists among the most enlightened nations, backed by the sternest sanctions it is possible to conceive. "A story is told of a man wandering on a dark night over Dartmoor, whose feet slipped over the edge of a pit. He caught the branch of a tree suspended over the terrible chasm, but, unable to regain the ground, shrieked for help. None came, though he cried out till his voice was gone; and there he remained dangling in agony until the gray light revealed that his feet were only a few inches from the solid ground! Such are the chief demons that bind men till cock-crow. Such are the apprehensions that waste also the moral and intellectual strength of man, and murder his peace *as he regards the necessary science of his time to be cutting some frail tenure sustaining him over a bottomless pit, instead of a release from real terror to the solid ground.*"

The passages we have quoted will give an idea of our author's style and point of view. There is hardly a page of the work which does not contain sentences full of epigrammatic force. Speaking, for instance, of the divers forms ascribed to the devil, Mr. Conway says that "the whites painted him black, and the blacks, *with much more reason*, painted him white."

PARADOXICAL PHILOSOPHY: A Sequel to "The Unseen Universe." London and New York: Macmillan & Co. 1878. Pp. 235. Price, $1.75.

THE readers of "The Unseen Universe" will find in the present volume, which is by the same authors, a further discussion of the question of a future state. The work purports to report the proceedings of an imaginary "paradoxical society" at one of its anniversary meetings, and the conflicting views of many different schools of thought upon this subject are set forth with considerable force, and in a way that will interest the most listless reader. The whole subject is treated in the light of modern science; and, though the problem is not brought one hair's breadth nearer to a solution by the clash of arguments, new points of view are at least indicated, new proofs suggested, new difficulties shown to lie in the way of accepting whether the materialistic or the idealistic philosophy. But no less hopeless appears to be the attempt to effect a reconciliation between these two; and the ancient enigma, "Whither are we going?" still remains.

HOW TO BE PLUMP, OR TALKS ON PHYSIOLOGICAL FEEDING. By T. C. DUNCAN, M. D. Chicago: Duncan Brothers. 1878. Pp. 60. Price, 50 cents.

THE doctor who writes this book had the good fortune, several years ago, to be employed in the family of an oyster-dealer, and, though it is not stated that oysters were at the time a "legal tender" in Chicago, they appear to have suddenly become a rather large element in our author's bill of fare, since he often ate them when he did not want them, "rather than let them spoil." "Other food" was taken "after or with the oysters"; and whether absence of the harassing cares of a large practice can be counted in or not, certain it is that the doctor, oddly enough, soon found himself grow-

ing stout. "The quieting effects of a few pounds of fat" gave him a "clew to much of the restless activity of Americans"; this led to "much thought" during the next ten years on the subject of "physiological feeding," and, as one of the results, we have the present book. All there is of value in its sixty pages could be better said in as many lines, and they would then contain nothing beyond the merest commonplaces of physiology.

WHAT IS THE BIBLE? By J. T. SUNDERLAND. New York: Putnam's Sons. 1878. Pp. 189. $1.

THE object of the author in composing this book was to help readers of the Bible to be intelligent readers, not only in the small and meager sense of knowing by heart a multitude of texts, but also in the larger and more worthy way of understanding that book as a whole—whence it came, how it came, what it is, and what relation it bears to other sacred books of the race. The Bible is treated with a reverent spirit by Mr. Sunderland, but that reverence does not prevent him from discerning and pointing out its blemishes. He compares the book to a gold mine, rich indeed in the precious metal, but still a *mine*. There are fools who insist that the whole "output" of this mine is pure gold; no less is the folly of others who, because they see earth and quartz mixed with the gold, declare that the mine contains no gold. "The part of rational men and women," says the author, "surely is to delve earnestly in the mine, casting out, without hesitation, what plainly is not gold, but saving and treasuring up what clearly is gold."

HOW TO PARSE. By Rev. E. A. ABBOTT, D. D. Boston: Roberts Brothers. 1878. Pp. 343. $1.

THE title of this book is not a very attractive one, and will repel, we fancy, rather than win readers. "Parsing" has fallen into disrepute, and few persons will care to know how it should be performed. But if, overlooking the title, we examine the book, it will be found to contain a great deal of valuable information. What is more, it will serve to give the student an insight into the scientific principles of English grammar.

THE NATURAL HISTORY OF THE AGRICULTURAL ANT OF TEXAS. By HENRY CHRISTOPHER MCCOOK. Philadelphia: The author (Academy of Natural Sciences). 1879. Pp. 310, with 24 Lithographic Plates. $4.

A MORE instructive and entertaining matter of study than the ant tribe it would not be easy to find in the whole animal kingdom outside of man; and, of all the ants, certainly none are more worthy of our attention than the species described in Mr. McCook's present work. A naturalist resident in Texas, the late Dr. Gideon Lincecum, had at sundry times between 1861 and the period of his death, some five or six years ago, contributed to the proceedings of various learned societies notes on the habits of the agricultural ant, but his observations, as we learn from Mr. McCook, were discredited by not a few entomological writers. It was the author's good fortune to confirm in almost every particular the results of the Texas naturalist, and to add to them a multitude of fresh observations of his own. We therefore heartily welcome the volume, not only on account of the information it contains touching the agricultural ant, but also because it is a triumphant vindication of one of the most ingenious of American naturalists. Mr. McCook, in successive chapters, treats of the surface architecture and work of the agricultural ants, their harvesting habits, their subterranean architecture, their modes of mining, their food and feeding, their "toilet, sleeping, and funeral habits," their social and (if the term be allowable) their political relations, their migrations and movements, their wars; and, finally, he gives a detailed description of their anatomy.

HOUSE AIR THE CAUSE AND PROMOTER OF DISEASE. By FRANK DONALDSON, M. D. Baltimore: Innes & Co. print. 1878. Pp. 23.

THE author insists on the necessity of frequently renewing the air of inhabited rooms. To the objection that fuel is too costly, and people can not afford to let in the cold air, he replies: "True, more fuel must be consumed. But is not the additional expense a small matter compared with the healthfulness resulting from it? *Fresh air is better worth paying for than even food; it is more essential to health.*"

WANDERINGS IN SOUTH AMERICA, THE NORTH-WEST OF THE UNITED STATES, AND THE ANTILLES, IN THE YEARS 1812, 1816, 1820, AND 1824, WITH ORIGINAL INSTRUCTIONS FOR THE PERFECT PRESERVATION OF BIRDS, ETC., FOR CABINETS OF NATURAL HISTORY. By CHARLES WATERTON, Esq. New edition. Edited, with Biographical Introduction and Explanatory Index, by the Rev. J. G. WOOD, with One Hundred Illustrations. London and New York: Macmillan & Co. 1879. Pp. 520. Price, $6.50.

THIS elegant volume opens with an interesting biographical sketch of the distinguished traveler, whose "Wanderings" has long been the delight of all lovers of natural history. From this sketch we learn that Charles Waterton was born in 1782, in Yorkshire, England. He was descended from a long line of distinguished ancestors, and in early boyhood began to develop that love of nature, power of observation, and originality of character for which he was afterward so celebrated. When ten years old he was sent away to school, and, although the first journey described in his book did not commence till twenty years later, his "wanderings" may be said to have begun at this time. In spite of the stern discipline to which he was subjected, his activity, enterprise, and love of adventure, led him into all sorts of scrapes, from which, however, he generally contrived to escape without serious harm. Such was his attempt to ride a cow, over whose horns he was quickly pitched; at another time he undertook a sail on the horse-pond in a wash-tub, with the usual fate of such daring navigators. Running away from school to go birds'-nesting, and throwing his pursuers off the track by hiding under the litter in a pig-sty, was another characteristic performance.

At fourteen he was transferred to a higher school, where, ranking among the foremost as a scholar, he also found peculiar opportunities for indulging his love of fun and freedom. His teachers early perceiving the bent of his disposition, were sagacious enough to give it fair play, by permitting him to use a portion of his time in carrying on a war of extermination against the rats that infested the place in enormous numbers. His success with these led to an extension of hostilities to the foxes, polecats, and rooks, that were also numerous in the neighborhood; he likewise held the post of organ-blower and foot-ball maker to the "entire satisfaction of the public." At eighteen he left school, remained a year at home, and then took a trip to Spain, where he learned the Spanish language. While visiting relatives in the city of Malaga, he suddenly found himself a prisoner, owing to an outbreak of the plague, which led to measures of rigid quarantine. He took the disease, but fortunately, owing to his simple mode of life and strong constitution, recovered from the attack. Fourteen thousand people perished in the city during that epidemic. Though the port was closed, and all avenues of egress carefully guarded, he succeeded in escaping from the city in time to avoid a second epidemid in the following year, which carried off thirty thousand more of the city's population. Returning to England, he spent some time there in recovering his shattered health, and then started for Demerara, in South America, to take charge of an estate belonging to his family. There he remained for eight years, when, owing to the death of relatives, the property passed into other hands. He now began his famous travels, setting out on his first journey from the town of Stabroek "to travel through the wilds of Demerara and Essequibo, a part of *ci-devant* Dutch Guiana, in South America." "The chief objects in view," he says, "were to collect a quantity of the strongest wourali poison; and to reach the inland frontier fort of Portuguese Guiana." With this start, which was made in April, 1812, the record of Waterton's observations and experiences known as the "Wanderings" begins.

The special objects of this journey were both attained, and a large amount of interesting information on other matters also gathered, but fatigue and exposure had told on the health of the "wanderer," and he found it necessary to return to England, where he remained for the next three years. In the spring of 1816, his health now being fully restored, he again started for South America, landing first at Pernambuco, and sailing thence after a brief stay for Cayenne in French Guiana. The forests of Demerara were, however, his objective point, and without delay he plunged into their wilds a second time, staying several months, and

giving particular attention to the fauna of the country, taking back with him to England a fine collection of birds. In February, 1820, he sailed a third time for Demerara, and, continuing his explorations for a season, returned to England at the end of a year with a larger number of specimens than he had before been able to obtain. But this time a stinging disappointment awaited his arrival. Although his specimens were intended solely for his own museum, and were none of them for sale, impudent and overzealous custom-house officials gave no end of trouble when he landed by detaining his cases of material, and subsequently exacting heavy duties as a condition of their release. Appeal to the Government did no good, and, smarting under a sense of the outrage, he retired to his home in Yorkshire, resolved not to expose himself to similar annoyance and insult again. Three years later, however, he started on his fourth and last journey, described in the "Wanderings," this time going first to New York, and, after a short trip in the United States, returning by the way of the British West Indies to Demerara. After a stay of a few months, mostly spent in further explorations, he resumed his homeward voyage, reaching England early in 1825.

Mr. Waterton was a keen observer, and in the regions which he visited permitted little in the line of natural history to escape him. The topography of the country, its plants and animals, and the character and habits of its human inhabitants, all received attention; and though at first many of his descriptions were met with incredulity and some of them even with derision, fifty years have served to confirm their accuracy in nearly every particular, and to show that, as an enthusiastic and painstaking investigator, Mr. Waterton had few equals and no superiors. Added to this, the story is simply and most charmingly told, an abundant sprinkling of quiet humor and occasional vivid descriptions of exciting adventures serving to enliven and give variety to the narrative. The "Wanderings" close with a chapter on taxidermy, in which the author attained remarkable proficiency, especially in the mounting of birds. He introduced many improvements in the art, and offers numerous valuable hints for those interested in the preservation of natural history specimens.

Besides the biography, which occupies the first five chapters of the book, Mr. Wood has supplied a full "Explanatory Index," which contains a large amount of valuable information regarding the animals and plants mentioned in the "Wanderings." Many of these were described by Mr. Waterton under their local names, which, for scientific purposes, were of little use. In type, paper, illustrations, and binding, the publisher has left nothing to be desired.

THE AMERICAN JOURNAL OF OTOLOGY. Edited by CLARENCE J. BLAKE, M. D. Quarterly. Vol. I., No. 1. New York: William Wood & Co. Pp. 80. Price, $3 per year.

As the editor of this new journal remarks in his introductory note, "the past ten years have seen a remarkable increase of interest in the study of the laws which govern the production and propagation of sonorous vibrations, and correspondingly in the structure, functions, and diseases" of the ear. Hence the "Journal of Otology" is a welcome addition to the list of American medical and scientific periodicals. The editor is assisted by a very strong staff, viz., Professor A. M. Mayer, Dr. Albert H. Buck, Dr. C. H. Burnett, Dr. J. Orne Green, and Dr. H. N. Spencer. The articles in the present number are: "Graphic and Photographic Illustrations of Sound-Waves," by the editor; "Growth of Aspergillus in the Living Human Ear," by Dr. C. H. Burnett; "Syphilitic Affections of the Ear," by Dr. A. H. Buck; "Use of Calcium Sulphide in the Treatment of Inflammations of the External Auditory Meatus," by Dr. S. Sexton; Book Notices; and Reviews.

INDUSTRIAL EDUCATION. By Professor ALEXANDER HOGG. Galveston, Texas: "News" Print. 1879. Pp. 52.

THE author, who is a Professor of Mathematics in the Agricultural and Mechanical College of Texas, in his first chapter sketches a course of studies suitable for an institution of that kind; in his second and third chapters he describes the present state of the Texas Agricultural College, and points out some of its more pressing needs.

AIR AND MOISTURE ON SHIPBOARD: A FRAGMENT OF APPLIED PHYSIOLOGY. By TH. J. TURNER, A. M., M. D., Ph. D. Pp. 15.

THE notion is prevalent that life on shipboard is especially healthy, and the doctors are constantly sending patients to sea for the benefits they are there expected to obtain. That the belief is an error, and the practice a mistaken one, this pamphlet abundantly proves. Indeed, according to the statistics which the author gives, few unhealthier places can be found than one of our modern naval vessels when in active service. This appears to be due mainly to foul air and a superabundance of moisture, both of which, as the writer points out, can be easily avoided by the substitution of a few simple sanitary measures for the stupid routine that now commonly controls in the management of ships.

ON THE GENEALOGY OF PLANTS (20 pp.), and ON THE NATURAL SUCCESSION OF THE DICOTYLEDONS (11 pp.). By LESTER F. WARD, A. M. Reprinted from the "American Naturalist."

THE first of these pamphlets begins with an indictment of the present system of botanical classification, which the author regards as altogether out of harmony with the facts of organic evolution as developed during the last twenty years; and as requiring the introduction of certain important modifications, some of which he outlines. The second pamphlet is a discussion of the classification of the dicotyledons, from the same point of view, namely, that of the evolutionist.

NOTES ON CLADOCERA. By EDWARD A. BIRGE, Ph. D., Instructor in the University of Wisconsin. Pp. 33, with Two Plates.

THIS is a technical description of several new species and one new genus of minute fresh-water crustaceans found by the author at different localities in this country. The water-flea (*Daphnia*) is a familiar example of the group.

THE AIR WE BREATHE. New York: S. Hamilton's Sons Print. Pp. 17.

WE have here a report of a Citizens' Committee on the nuisances of New York City, or rather on its "stench-factories"—slaughter-houses, fat-rendering establishments, etc.

THE SOUL AND THE RESURRECTION. By J. H. KELLOGG, M. D. Battle Creek, Michigan: "Review and Herald" Publishing Association. 1879. Pp. 224. Price, 75 cents.

HERE is another attempt at establishing harmony between science and the Bible. The author looks on science and the Bible as "complementary revelations," though the latter he regards as of by far the greater importance. Still, he does not by any means require that science should surrender at discretion to its "superior." On the contrary, indeed, not a few of our author's propositions seem to us to imply that the whole body of "revealed truth" is subject to revision and correction by science. The orthodox reader will be shocked when he finds the harmonizer plainly declaring that "the study of mind is now a subject for the physiologist," and that "the soul is neither conscious nor immortal."

PRINCIPAL CHARACTERS OF THE AMERICAN JURASSIC DINOSAURS. With Plates. Pp. 6. A NEW ORDER OF EXTINCT REPTILES. By Professor O. C. MARSH. With Plates. Pp. 8.

THESE papers are reprinted from the "American Journal of Science." We gave an abstract of each of them on their appearance in our contemporary.

THE PRINCIPLES OF BREEDING. By Professor W. H. BREWER. Pp. 20.

PROFESSOR BREWER is an authority on the subject which he has treated in this too brief paper. It is reprinted from the reprint of the Secretary of the New Hampshire Board of Agriculture.

NOTES ON THE APHIDIDÆ OF THE UNITED STATES. By C. V. RILEY and J. MONELL. With Plates from Hayden's Survey. Pp. 32.

IN this paper are set forth many interesting biological facts relating to the gall-making *Pemphiginæ*. Such facts possess a peculiar importance just at present, on account of the close relationship between these insects and the *Phylloxera* of the grapevine.

ART ANATOMY. By Dr. A. J. HOWE. Pp. 23.

THE painter and sculptor will find many a valuable hint in this unpretending little essay.

PUBLICATIONS RECEIVED.

The Speaking Telephone, Electric Light, and other Recent Electrical Inventions. By George B. Prescott. With Illustrations. New York: D. Appleton & Co. 1879. Pp. 616. $4.

Report of the British Association for the Advancement of Science (1877). London: John Murray. Pp. 679.

Die Entwickelung des Menschengeschlechtes. Von Dr. Adelrich Steinach. Basel: Benno Schwabe; New York: Schlaepfer, 109 Allen St. 1878. Pp. 687. $2.50.

The Currency Question from a Southern Point of View. By R. W. Hughes. New York: Putnam's Sons. 1879. Pp. 222. $1.25.

Testing of Water-Wheels and Machinery. By James Emerson. Springfield, Massachusetts: Weaver, Shipman & Co. print. 1878. Pp. 216. $1.50.

Naval Hygiene; Human Health. By Joseph Wilson, M. D. With Colored Lithographs. Philadelphia: Lindsay & Blakiston. 1879. Pp. 274. $3.

Report of the United States Entomological Commission (1877). With Plates. Washington: Government Printing-Office. 1878. Pp. 771.

The Young Scientist. Vol. I. New York: Industrial Publication Co. 1878. Pp. 164.

Reading as a Fine Art. By Ernest Legouvé. Boston: Roberts Bros. 1879. Pp. 97. 50 cents.

Report of the Observations of the Total Solar Eclipse (1878) made at Fort Worth. Leonard Waldo, Editor. Cambridge: Press of John Wilson & Son. 1879. Pp. 60.

Habit and Intelligence. By John Joseph Murphy. Revised edition. London and New York: Macmillan. Pp. 631. $5.

After Death what? By Rev. W. H. Platt. Revised and enlarged. San Francisco: Roman & Co. Pp. 209. $1.25.

Health, and how to promote it. By Richard McSherry, M. D. New York: D. Appleton & Co. Pp. 196. $1 25.

Archivos do Museu nacional do Rio de Janeiro. With Plates. Rio de Janeiro: Typographia do imperial instituto artistico. 1878. Vol. II., pp. 175; Vol. III., pp. 50.

Proceedings of the New England Cotton Manufacturers' Association. Boston: A. Williams & Co. print. Pp. 79.

Vousseoir Arches. By William Cain, C. E. New York: Van Nostrand. 1879. Pp. 196. 50 cents.

Journal of Physiology. Michael Foster, M. D., Editor. With Plates. London and New York: Macmillan. Vol. I, No. 6. Pp. 70. $5.25 per year.

American Statistical Review. Quarterly. New York: D. Appleton & Co. Vol. I., Part 1. Pp. 120. $5 per year.

A Rational View of the Bible. By Newton M. Mann. Rochester, New York: Charles Mann print. 1879. Pp. 136.

The Horse and his Diseases. By B. J. Kendall, M. D. Enosburg Falls, Vermont: Published by the Author. Pp. 89. 25 cents.

Proceedings of the American Chemical Society. New York: Baker & Godwin print. 1879. Vol. II., No. 4. Pp. 24.

Chemical Examinations of Sewer Air. By Professor William Ripley Nichols. Boston: Rockwell & Churchill print. 1879. Pp. 16.

The Wisconsin Tornadoes of May 23, 1878. By W. W. Daniels. With Plates. Pp. 41.

Philosophy of Christianity. By Pliny E. Chase. Pp. 31.

The Hydatiform Mole. By J. W. Underhill, M. D. Cincinnati: "Lancet" print. 1879. Pp. 20.

The Female Generative Organs in their Medico-Legal Relations. By the same Author. New York: W. Wood & Co. Pp. 20.

Flora of Richmond County, New York. By Arthur Hollick and N. L. Britton. Staten Island: Published by the Authors. 1879. Pp. 36. 50 cents.

Annual Report of the Schools of the Province of Ontario (1877). Toronto: Hunter, Rose & Co. print. Pp. 260.

The Devonian Brachiopoda of Pará, Brazil. By Richard Rathbun. From "Proceedings of the Boston Society of Natural History." Pp. 39.

Sketch of New Zealand. By I. C. Russell. From "American Naturalist." Pp. 13.

Beneficial Influence of Plants. By J. M. Anders, M. D. From "American Naturalist." Pp. 15.

Relation of the National Government to Science. Speech of Hon. J. A. Garfield. Washington. 1879. Pp. 7.

Industrial Arbitration and Conciliation. By Joseph D. Weeks. Pittsburgh, Pennsylvania: Anderson & Son print. Pp. 16.

The Triassic Formation of New Jersey and the Connecticut Valley. By I. C. Russell. New York: Gregory Bros. print. Pp. 35.

The Animal, Vegetable, and Mineral Kingdoms. By Mrs. N. B. Walker. New York: Wilbur & Hastings print. 1879. Pp. 18.

Report of the Freedmen's Aid Society of the M. E. Church (1878). Cincinnati: Book Concern. Pp. 64.

The Cobden Club. Letter by S. S. Boyce. Pp. 5.

Nature and Possibilities of Social Science. By Pierce Burton. Aurora, Illinois: "Herald" print. Pp. 8.

Common Sense on the Salt Question. By Henry A. Mott, Jr. New York: Nesbitt & Co. print. Pp. 11.

Natural Method in Language. By John E. Earp. Indianapolis: Douglass & Carlon print. 1879. Pp. 8.

POPULAR MISCELLANY.

The History of Map-making.—The President of the American Geographical Society, Judge Daly, in an address on the history of map-making previous to the time of Mercator, expressed his belief that the cartographic art is as old as, or even older than, the invention of the alphabet. The earliest map or topographical design extant, so far as we know, is the ground-plan of the town of Susa (in the Bible Shushan). This is assumed to date from the seventh century before our era. According to Strabo, Anaximander (born 612 B. C.) first represented the world in a map. The earth at that time was held to be a flat, circular plain entirely surrounded by the ocean-river. Greece was in the center of the plain. The great central sea of the inhabited region was the Mediterranean. The farthest point known on the west was the Pillars of Hercules

(strait of Gibraltar). Parmenides (born 513 B. C.) is said by Diogenes Laertius to have been the first to assert the sphericity of the earth, and that it is situate in the center of the universe. Strabo credits Parmenides also with having been the first to divide the globe into five zones, or *climates* as they were called. Passing lightly over the twelve centuries between Ptolemy and the awakening of maritime enterprise which led to the discovery of America, Judge Daly spoke of the large map of the world constructed in Venice in 1457 by Fra Mauro. This map was painted on the wall of a convent in Venice, and it is remarkable not only for the extent of the geographical information it embodies, but for the artistic skill with which it is executed. But even the maps constructed after the time of Columbus and Magelhaens in their delineation of the outline of countries were very defective, and especially in respect to the American Continent. The accessories to geographical knowledge had become so vast, that the work of giving the whole surface of the earth as far as known, in all its details, with any approximation to correctness, was not accomplished till Mercator produced his great map of the world in 1569. In this map he introduced what has ever since been known as Mercator's projection, which not only gives the world in one view, but by a very curious and simple contrivance showed the most effectual way for a vessel to sail on a straight line over a curved surface, and thereby solved what was before one of the most difficult problems in navigation.

Fiords of Glacial Origin on Long Island.—In a paper by Mr. E. Lewis, Jr., read before the Natural History Section of the Long Island Historical Society, some account is given of the fiords which occur on the north side of Long Island, bordering Long Island Sound. In a distance of fifty miles eight of large size occur, penetrating the island to near its center. There are several small ones, remains evidently of large valleys that have been shortened by wearing away of the banks at the sound-shore. The waters of the sound extend into the large valleys from two to six miles, forming safe and beautiful harbors. Fiords, common on rocky coasts, like those of Maine or Greenland, are not frequent in the drift, but those described are singularly perfect in form. They are simply long, deep valleys, from half a mile to a mile broad, their source being in the hill region of the central part of the island. The depth of water in the deep portions of the fiords is from ten to thirty feet, but in a few places where the tidal currents are rapid depths of forty and even fifty feet are found. It is quite certain that sediment is slowly accumulating in the harbors, and is already of considerable thickness. Piles have been driven in one instance through forty feet of soft ooze, and meadows now occupy the upper portions of the valleys. The banks vary in elevation. The general elevation of the country throughout the region may be 150 feet above tide, but it is very undulating, being traversed by a great number of small lateral valleys, which open into the great fiords, chiefly on their easterly side. On the west side of Hempstead Harbor (Roslyn) the bank is 250 feet high, and at one point known as "Beacon Hill" attains an elevation of 307 feet. If to this height we add the depth of water and of sediment in the harbor, it will show that the extreme depth of the valley was not less than 350 feet when its bottom was swept by a glacial stream. There is reason to believe that in several instances these fiord valleys were once continuous southward to the ocean, and the site of glacial rivers flowing in that direction. They probably became filled with *débris* from the melting glacier, as it finally yielded to a change of climate. From that time the discharge of glacial water was northward through what is now Long Island Sound. The conclusion is, that nearly all the fiords in question are not eroded valleys, but are what remains of river valleys, maintained as such, while the deposit of drift went on. The lateral, or small valleys, referred to were mainly produced by erosion, but why they occur so largely on the easterly side of the great fiords is not explained.

Rainfall and Sun-spots.—The relation between rainfall and sun-spots is a subject which has been discussed with no little heat for a few years past. Of speculation and theory there is more than enough, and it is

time to collect and note the facts. Here is a table showing the readings of the Nilometer for thirteen years, from which it is clear that the river Nile, during that time at least, does not confirm the rule, "Maximum spots, maximum rainfall":

Years.	Depth of the Nile.	
1866	28½ feet	minimum spots.
1867	24½ "	minimum spots.
1868	19 "	
1869	29½ "	
1870	25½ "	
1871	28½ "	
1872	25½ "	maximum spots.
1873	20 "	
1874	29 "	
1875	24 "	
1876	25 "	
1877	18 "	minimum spots.
1878	30 "	

The Vertebral Articulations in Birds.—Professor Marsh, in the "American Journal of Science and Arts" for April, essays an explanation of the peculiar saddle-shaped articulation seen in the vertebræ of birds. Between *Ichthyornis* and *Hesperornis*, two birds with teeth from the Cretaceous, there is the widest conceivable difference as regards this part of the skeleton, in *Hesperornis* the ends of the centrum being saddle-shaped, as in ordinary birds, while in *Ichthyornis* the articulation of the centrum is cup-shaped. But in the third cervical vertebra of *Ichthyornis*, Professor Marsh catches nature in the act, as it were, of forming a new type, by modifying one form of vertebra into another. Following this hint, the connection between these widely divergent types of structure soon becomes apparent, and the development of the modern form of avian vertebra from the fish-like biconcave form finds a solution. In the anterior articulation of this vertebra of *Ichthyornis* the surface looks downward and forward, being inclined at an angle of nearly 60° with the axis of the centrum. In vertical section it is moderately convex, while transversely it is strongly concave, thus presenting a near approach to the saddle-like articulation. None of the other vertebræ of *Ichthyornis* possesses this character. "This highly specialized feature," remarks Professor Marsh, "occurs at the first bend of the neck, and greatly facilitates motion in a vertical plane. If, now, we consider for a moment that the dominant motion in the neck of a modern bird is in a vertical plane, we see at once that anything that tends to facilitate this motion would be an advantage, and that the motion itself would tend directly to produce this modification. With biconcave vertebræ, the flexure in any direction is dependent on the elasticity of the fibrous tissue that connects them, as the edges of the cup do not slide over each other. An increasing movement in the neck of *Ichthyornis* in a vertical plane would tend to deflect the upper and lower margins of the circular cup, and to produce a vertical constriction, and at the same time to leave the lateral margins projecting; and this is precisely what we have in the third vertebra. This modification of the vertebræ would naturally appear first where the neck had most motion, viz., in the anterior cervicals, and gradually would be extended down the neck; and, on to the sacrum, if the same flexure were continued. Behind the axis, or where the vertical motion prevails, we find in modern birds no exception to the saddle articulation in the whole cervical series. In the dorsal vertebræ, this cause would be less efficient, since the ribs and neural spines tend to restrict vertical motion, and hence to arrest this modification. This region, then, as might be expected, offers strong confirmatory evidence of the correctness of the above explanation; for here occur, among modern birds, the only true exceptions known in the presacral series to the characteristic saddle-shaped articulation."

Professor Tyndall on Sound.—Professor Tyndall is this season giving a course of lectures on sound at the London Royal Institution. In the first lecture he illustrated by many experiments the action of sound-waves, and explained the mechanism of the ear. In treating of the velocity of sound, he said that at the temperature of 32° Fahr. air conveys sound-waves 1,090 feet per second, but that this rate varies with every variation of the temperature. It is well known that, when a mechanically striking bell is placed under a receiver exhausted of air, no sound is heard. Professor Tyndall showed by experiments that when a little air, about one fourth, is admitted into the receiver, the sound is feeble only; but on introducing a little hydrogen, the sound was again stilled. This fact was known to

Sir John Herschel, and he gave the explanation that hydrogen *breaks the continuity of the medium*. But this is not the true explanation. Professor Stokes, paying attention to the fact that when a tuning-fork is struck and held in air it gives out but little sound, investigated the subject, and arrived at the conclusion that air is so mobile that it runs around the tuning-fork without being thrown into waves. Check this "running round" by holding a card at one side of the fork, and the sound is augmented. Now, hydrogen is more mobile still than air, and hence the probable explanation of the bell not sounding in it is, that the hydrogen "runs round" so readily that it is not thrown into waves. Alluding to Newton's attempt to reconcile his theoretical calculation of 916 feet per second with the experimental results of 1,090 feet per second as the velocity of sound, Professor Tyndall said that the philosopher had forgotten to take into account the heat developed by the sound-wave in its own path. By the aid of the thermopile and galvanometer arrangement, the lecturer showed that a very gentle and small compression of air does produce heat. Several experiments to show the passage of sound through wood, water, and other bodies were made in the concluding part of the lecture. In one of these experiments music played in the cellars of the Institution was made audible by a connecting wooden rod rising into the lecture-hall, a common wooden tray being alternately held on the top of the rod and removed again. The rod itself had not surface enough to give vibrations which can be heard, but the larger surface of the tray gave the "magic music."

An ingenious and very simple method of measuring the velocity of sound in air and other gases is described by M. Bichat, in the "Journal de Physique." A tube about ten metres long, made of tin plate, is bent so that its extremities *A* and *B* are near together. The end *A* is closed by an India-rubber membrane; the end *B* carries a cork with a glass tube through it, which communicates, by means of an India-rubber tube, with a Marey's manometric capsule. These capsules are arranged in front of a blackened cylinder, so that the extremities of their levers rest upon the same generating line. Close by these a tuning-fork, making one hundred vibrations per second, is placed, and inscribes its vibrations side by side with those of the manometric capsules. The experiment being so arranged, a slight shock is given by the hand to the membrane *A*, the blackened cylinder meantime being turned. The capsules register the point of departure and the point of arrival, while the tuning-fork gives the time. In this way the velocity of sound in air was found by M. Bichat to be 333.3 metres per second. By means of two tin tubes, placed one above the other, we may in a single experiment demonstrate the difference of velocities of sound in air and in hydrogen; but it is difficult, in consequence of diffusion through the India-rubber, to keep the tube full of pure hydrogen.

Recent Exploration of Wyandotte Cave.—Wyandotte Cave, in Crawford County, Indiana, has a total length of twenty-three miles, including all the avenues; it includes many fine halls and domed chambers, the largest of which has a circumference of one thousand feet, and is said to be two hundred and five feet high. The Rev. H. C. Hovey mentions, in "The American Journal of Science," an important discovery made in this cave last April by a party of students from Wabash College. Forcing their way through a low, narrow passage from the locality known as Rugged Pass, the party entered a realm of chaos. "Pits, miry banks, huge rocks, are overhung by galleries of creamy stalactite, vermicular tubes intertwined, frozen cataracts, and all, in short, that Nature could do in her wildest and most fantastic mood." One of the curiosities of this place is a row of stalactites on which a musical chord can be struck or a melody played. What is known as the "Old Cave" was worked by saltpeter miners in 1812, and sundry acts of vandalism have been charged on them which more probably were done by the aborigines. The finest stalacto-stalagmitic column probably in the world is the Pillar of the Constitution in this "Old Cave." It is forty feet high, twenty-five feet in diameter, and it rests on a base three hundred feet in circumference. The weight of this immense mass of alabaster caused the underlying rocks to settle, and this in turn cracked the base, caus-

ing great crevices. At some former time a large segment was cut from the base of this column. Starting from one of these crevices, an excavation was made, cutting a mass from the base having an arc of thirty feet, and making a cavity in the pillar itself ten feet wide, seven feet high, and five feet deep. This excavation has hitherto been regarded as a deliberate attempt of the miners to fell the column, but Mr. Hovey thinks the work must have been done a thousand years ago.

Commercial Products of New Caledonia.—M. Jules Garnier, who has spent three years in New Caledonia investigating its mineral resources, states that all the principal vegetable productions of the tropics grow well on that island, though, with the exception of coffee and tobacco, they are subject to periodical destruction by invasions of grasshoppers. Cotton, moreover, is liable to damage during the rainy season, which, coinciding with the gathering of the crop, destroys the produce. There are several native oil-yielding plants, and the culture of the mulberry and silkworm have been introduced with success. The forests contain many useful timber-trees; but the most active industry is the raising of cattle, in which an active export trade is carried on with Australia. Of other animal products there is nothing of commercial value except the fish, which are abundant and of great variety. The chief source of wealth in the island is, however, its metallic products. It is rich in gold, copper, and nickel, the latter presenting itself in the form of a magnesian hydro-silicate, called by Professor Dana Garnierite. The native inhabitants number thirty-five thousand, and the whites seventeen thousand. The recent insurrection will not interfere with the progress of the colony.

Professor A. Agassiz's Zoological Laboratory.—Professor Alexander Agassiz's zoological laboratory at Newport is admirably contrived to accommodate a small number of workers. It is forty-five by twenty-five feet. The whole of the northern side of the floor, upon which the work-tables and microscope-stands are placed, is supported on brick piers and arches independent of the brick walls of the building. The rest of the floor is supported entirely on the outside walls and on columns on the north side. This gives to the microscopic work the great advantage of complete isolation from all disturbance caused by persons walking over the floor. The material for the laboratory procurable at Newport is abundant. The dredging is fair and not difficult, as the depth in the immediate neighborhood does not exceed twenty to thirty fathoms. The pelagic fauna, however, is the most abundant. During the course of each summer, by the use of the dip-net, representatives of all the more interesting marine forms can be found. The laboratory stands on a point at the entrance of Newport Harbor, past which sweeps the body of water brought by each tide into Narragansett Bay, and carrying with it everything which the prevailing southwesterly wind drives before it. Newport Island and the neighboring shores form the only rocky district in the long stretch of sandy beaches extending southward from Cape Cod — an oasis, as it were, for the abundant development of marine life along its shores.

Making Sound-Vibrations visible.—A very ingenious method of recording articulate vibrations by means of photography has just been invented. The apparatus (says "Galignani's Messenger") consists of a steel mirror capable of oscillations on a diametral axis, to the back of which is attached a lever connecting it with the center of a telephone-disk arranged with an ordinary mouthpiece. Whenever the disk is made to vibrate, the mirror oscillates with it, and a beam of sunlight thrown on the reflector from a heliostat describes lines of light on a suitably prepared screen. If the latter be movable at right angles to those lines of light, and carries a collodion film, the oscillation of the light is recorded on the prepared surface as a more or less complex curve having the peculiarity of the sound-wave which caused each particular motion. Another and simpler phoneidoscope is suggested by a writer in "Nature": it may be made without the aid of any apparatus whatever, by bending the forefinger and thumb of one hand so as to form a circle, and then with the other hand draw-

ing over the aperture a film of soapsuds. By turning the wrist, the angle made with the direction of the light may be readily adjusted; a motion of the elbow alters the distance from the mouth, and the tension of the film can be exactly regulated by moving the thumb and finger. On singing or speaking to the film when in proper tension, beautiful figures appear, which may be reflected direct from the film on a screen. The experiment is extremely curious and interesting.

George Bidder, the "Calculating Boy."—There died lately in England a man of prodigious arithmetical power, whose mental faculties would afford matter for profound research to the psychologist. George Bidder made his mark in early life as a "calculating boy"; but in him one overgrown faculty did not eclipse all the other mental powers, for throughout life (he died aged seventy-two years) he evinced first-rate business ability, and in fact accumulated a large fortune by his own exertions. Nor did his mathematical faculty decline as his other powers matured; to the last he was capable of the same astonishing feats of calculation which made him remarkable as a boy. Instances of his extraordinary powers are given in a letter written by James Elliot, Professor of Mathematics in Queen's College, Liverpool, who was Bidder's fellow student in Edinburgh. Of these we quote two: A person might read to Bidder two series of fifteen figures each, and, without seeing or writing down a single figure, he could multiply the one by the other without error. Once, while he was giving evidence before a Parliamentary committee, counsel on the opposite side interrupted him with, "You might as well profess to tell us how many gallons of water flow through Westminster Bridge in an hour." "I can tell you that too," was the reply, and he gave the number instantaneously.

Certain interesting facts are mentioned with regard to the possession of the same or similar powers by members of Bidder's family. His eldest son, who is a successful barrister, can play two games of chess simultaneously without seeing the board. Like his father, he can multiply fifteen figures by fifteen without seeing them, but by a peculiar process. One of the grandsons showed a very marked degree of mechanical ingenuity. Even the granddaughters possess extraordinary powers of calculation. George Bidder's elder brother, a Unitarian minister, was not remarkable as an arithmetician, but had an extraordinary memory for Bible texts, and could quote almost any text in the Bible, and give chapter and verse. Another brother was an excellent mathematician, and was actuary of a great life-insurance company.

Peruvian Antiquities.—In an article on Peruvian antiquities, published in the "Kansas City Review of Science and Industry," Dr. E. R. Heath gives an interesting account of the vast wealth of ruins with which the land of the Incas is overstrewed. Go where you will in Peru, and relics of the past meet your eye either in ruined walls, watercourses, terraces, or extensive areas covered with broken pottery. Dr. Heath takes as an illustrative instance the Jequetepeque Valley. Here the bottom-lands of the river are from two to three miles in width, with a southern sloping bank, and the northern a perpendicular one nearly eighty feet high. Beside the southern bank, near the point where the river empties into the sea, is an elevated platform, one quarter of a mile square and forty feet high, all of adobe. A wall, fifty feet wide, connects it with another distant a few hundred yards, which is 150 feet high, 200 feet across the top, and 500 feet at the base, and nearly square. This latter structure was built in sections or rooms ten feet square at the base, six feet at the top, and about eight feet high. These rooms were afterward filled with adobes, then plastered on the outside with mud and washed in colors. All the Peruvian mounds of this class have on the north side an incline as a means of access. On the north side of the river, on the top of the bluff, are the ruins of a walled city two miles wide by six miles long. In following the river to the mountains you pass ruin after ruin, one artificial mound (*huaca*) after another. At Tolon, a town at the base of the mountains, the valley is crossed by walls of bowlders and cobble-stones, ten, eight, and six feet high, one foot to eighteen inches wide at the top and two to three feet at the base,

inclosing the ruins of a town one quarter of a mile wide and more than a mile long. At this point the railroad enters the Jequetepeque Valley. For eight miles it crosses a barren sand-plain of more than fifteen miles in length, covered with ruined walls, watercourses, dead algaroba and espino trees, with fragments of pottery and sea-shells, even to nine feet in depth, mixed with the sand. The bases of the mountains have, in a good state of preservation, many thousand feet of an old watercourse, while their sides to the perpendicular parts are lined with terraces. This watercourse, now dry, can be traced for the distance of forty-five miles.

Important Discovery in Entomology.—Mr. Gray, of Albany, has been engaged in the study of our diurnal *Lepidoptera* for many years. He has made the discovery, as published in the "Canadian Entomologist," that our Eastern species of *Liminitis*, four in number, are not distinct. They belong to a single plastic genetic group, of which *arthemis* is the most northern, *proserpina* intermediate between *arthemis* and *ursula*, and the red *disippus* the most southern. He has collected them in vertical altitudes on hills in the Middle States and New England, and has intermediary specimens half bluish and red between the two most strikingly contrasted species of the group *ursula* and *disippus*. This discovery is the most remarkable in the group announced since the recognition of the female form of *diana* by Mr. W. H. Edwards. In general interest it far surpasses that discovery, and we expect will be more generally noticed.

California Climates and Consumption.—The conditions requisite in a health resort for consumptive patients are relative dryness of atmosphere and an agreeable and equable temperature throughout the year. There are in the State of California a number of localities in which these conditions are happily combined, and which afford to the consumptive opportunity for living out-of-doors at all seasons. In the "Alta California Almanac" is published a table setting forth the mean relative humidity, and mean temperature, summer and winter, of the most noted sanitaria in the State, from which we make a few selections. The places which have the least humidity are Atlas Peak and Blakes, the former 1,500 feet above sea-level, and the latter 2,100, and both situated in a mountain-ridge east of Napa Valley. This ridge is thirty miles from the sea, is seldom covered by fog, is beyond the reach of the cold sea-breezes, and is warmer in winter and cooler in summer than the valleys on each side. At Atlas Peak the relative humidity is in summer 39°, in winter 51°—"summer" standing for the "dry season" from May to October, and "winter" for the "wet season" from November to April, inclusive. The mean temperature for January at Atlas Peak is 50° Fahr., and for July 74°. At Blakes the relative humidity for summer is 39°, and for winter 60°; and the mean temperature for January is 45°, for July 73° Fahr. These two localities are only a few miles distant from one another, and are within five or six hours' travel from San Francisco. Other localities are represented in the table as follows:

STATIONS.	RELATIVE HUMIDITY.		MEAN TEMPERATURE.	
	Summer.	Winter.	January.	July.
Camp Apache.	57°	56°	38°	84°
Visalia.....	42	72	45	80
Anaheim.....	64	60	50	68
Fort Yuma...	58	68	56	97
Los Angeles..	66	64	52	75
Santa Barbara	71	67	53	68
San Diego....	75	69	51	72
San Rafael....	65	83	48	67

Resurvey of Yellowstone Park.—A good summary of the work done by Hayden's Survey of the Territories during the season of 1878 is published in the "Naturalist," from which we learn that the *personnel* of the Survey was divided into four parties: one for the extension of the primary triangulation northward, two for topographical and geological work, and one for photography and special work in geology. All the parties left the Union Pacific Railroad at Point of Rocks and Green River stations about July 25th, and proceeded northward toward the Yellowstone National Park. To the second division was assigned the duty of making an exhaustive survey of the park and its surroundings, and to the third the exploration of the Wind River range and the Snake River country. The primary tri-

angulation was extended over about 12,000 square miles. Materials were collected for a topographical map of the Yellowstone Park, on the scale of one mile to an inch. Its geology was studied minutely. A peak of the Wind River range, named Fremont's Peak, was found to be over 14,000 feet in height above the sea; no trace could be seen of the presence of man on its summit at any time. Three glaciers were discovered on the east side of the Wind River Mountains. The object of again surveying the Yellowstone Park was to bring it under the system of triangulation, which has been very successfully employed in Colorado, and to make the entire work uniform. All the old hot-spring basins were resurveyed and mapped, soundings and temperatures of several thousand hot springs were made, and the action of the geysers carefully studied. Over fifty fine photographic views were obtained of the bowls and other curious ornamental details of the Hot Springs.

The Personal Equation.—One of the principal defects of "our primary mathematical instrument," the human mind itself with its organic apparatus, is very clearly pointed out by W. Mattieu Williams. This defect makes itself apparent in certain astronomical observations, when the observer has to note the moment at which a star appears to touch the wire or wires stretched across the field of a telescope. The old way of doing this was to look at a clock as the star approaches the wire, count the beats of the clock, and then note at which beat or fraction of the beat the transit of the wire occurs. Despite the apparent simplicity of this operation there is no human being whose eye, ear, and internal nervous apparatus of perception and volition are sufficiently perfect to perform it accurately. None of us either sees, hears, or feels instantaneously. The sensation has to be transmitted from the external organ of sense to the nervous center, and the response has to be transmitted outward. These operations involve time. Nor is that all: they require a different length of time for different persons, different constitutions. Thus in the same observatory there may be three assistants, A, B, and C, and they are tested by making a number of corresponding observations. In every case it will be found that A is say a quarter of a second ahead of B, and B half a second ahead of C. What is to be done? If all erred alike—if all observers required just half a second to collect their sensations of sight and hearing, and to bring them to bear upon the same perception, then by setting the clock half a second ahead of the true time, the needed correction would be made. But, failing this, some personal standard of comparison must be taken, and the observers rated to this standard like chronometers. This is done in observatories, and the result is called the "personal equation" of the individual observer. And not only has the personal equation of each observer to be determined on his entrance upon his duties, but it demands periodical revision, for it varies with age and constitutional conditions.

Use of the Balloon in Arctic Exploration.—In a paper read before the London Aëronautical Society, Mr. Brearey, its secretary, advocated the employment of balloons in polar exploration. Referrring to the last English polar expedition, Mr. Brearey said that, instead of a seventy days' journey to accomplish about seventy miles, at a fearful cost of life and suffering, consequent on having to drag over ice hummocks sleds containing provisions, the whole of the stores could have been conveyed over the heads of the explorers, and the men holding the ropes of this floating observatory would have been assisted by the upward tendency of the balloon. The question is, Would the daily consumption of stores compensate the leakage of gas? and its answer is found in Beaumont's history of the balloon as employed in the United States war of the rebellion. He writes that "the balloon when inflated can, unless in very windy weather, be very readily carried. Twenty-five or thirty men lay hold of cords attached to the ring and march along, allowing the machine to rise only sufficiently to clear any obstacle." He had frequently seen it carried thus without the least difficulty. As for the leakage of gas, by the use of proper varnish it might be so checked that at the end of a fortnight the balloon could make an ascent without being replenished. Re-

marks by various members of the Society followed the reading of the paper; they are briefly stated in the "Monthly Journal of Science," and are, on the whole, favorable to Mr. Brearey's views. Mr. Glaisher saw no reason why the balloon should not be made available in arctic exploration, and he hoped that, if there were another expedition, the balloon would be tried and the question settled. It would certainly, if used in connection with a sled, enable the explorers to travel much more rapidly than they can at present. Touching on the use of the balloon as an observatory, he said that, when he was only half a mile over London, he could see Margate and Brighton. This showed how much may be seen from a comparatively small elevation.

A Blood-sucking Squirrel.—Dr. Richard E. Kunze gives in "Science News" an entertaining account of a pair (male and female) of pet gray squirrels, one of which, the male, he detected in the act of sucking the other's blood. Having noticed that the female looked emaciated, and that in moving about she dragged a hind leg, Dr. Kunze made an examination, which resulted in the discovery of a circular hole in this leg directly over the hamstring muscles, extending through the entire thickness of the skin. The edges of this opening, or sore, which was of the diameter of a lead-pencil, looked smooth and blanched. Now, it could not be the result of a puncture or any other wound, because there was present neither inflammation nor discharge. It had the appearance of an artificial issue, was sensitive but not painful. For a time he was puzzled to account for the hole, but at last he caught her companion in the act of sucking her blood. The "vampire" was seen to bury his snout deeply in the fur in the direction of the sore. Soon the female squirrel, which had before been asleep, gave a sharp cry. "My suspicions," writes Dr. Kunze, "were soon confirmed, that he was actually sucking out the very life-substance of his mate. For several days a number of medical friends kept a sharp lookout on Foxie's unnatural conduct. At first we simply drove him away from his mate whenever he was intentionally too near the coveted spot. We now had to beat him off. In proportion as we resorted to such severe measures, Foxie became more cunning, and with an Argus-eye would watch his chance to act unobserved. Finally, he became much bolder in his onslaughts. He would seize the leg whenever he could get hold of it. I have seen him time and again place both hands on each side of the 'sore,' apparently gently pressing down the edges, just as a little kitten in nursing would keep up a pressure on the milk-ducts, and simultaneously suck with all his might."

Blindness and its Causes.—According to the last census returns there were, in the United Kingdom of Great Britain and Ireland, 31,159 blind persons, or one in 1,015 of the population. The proportions in different parts of the kingdom vary greatly, from one in 635 in Cornwall to one in 1,367 in Durham; the proportion being higher in agricultural than in urban districts. It is gratifying to learn that though the actual number of the blind increases, their proportion to the seeing population diminishes—a change which is probably due partly to the improvements in ophthalmic surgery, partly to the greater attention paid to the laws of hygiene. But that there is still room for much improvement in the latter respect is only too apparent from the imperfect returns of the *causes of blindness* made by the directors of a few schools for the blind. Thus the report of the York School shows that out of 82 pupils 36 lost their sight from purulent ophthalmia. And similar results are observed in countries on the European Continent. For instance, according to Marjolin, out of 208 pupils in the Paris Institution for the Blind, 80 became blind from this disease, and 18 from small-pox; so that one half lost their sight from preventable causes. In the institutions of Germany the loss of sight from purulent ophthalmia is stated to be about 30 per cent.

The impairment of eyesight by habitual protracted reading has been made a special subject of study by M. Javel, a French physician, who also proposes a method of reducing to a minimum the damage so caused. In the first place, reading requires an absolutely permanent application of eyesight, resulting in a permanent tension of the organ. Secondly, books are printed in black

on a white ground; the eye is thus in presence of the most absolute contrast which can be imagined. The third peculiarity lies in the arrangement of the characters in horizontal lines, over which we run our eyes. If, during reading, we maintain a perfect immobility of the book and the head, the printed lines are applied successively to the same part of the retina, while the interspaces, more bright, also affect certain regions of the retina, always the same: the result is fatigue. Last and most important of all, in M. Javel's estimation, is the continual variation of the distance of the eye from the book. The accommodation of the eye to the page undergoes a distinct variation in proportion as the eye passes from the beginning to the end of each line; and this variation is all the greater in proportion to the nearness of the book to the eye, and the length of the line. In order to avoid these injurious effects, M. Javel advises frequent intermissions during reading. To reduce the contrast between the white of the paper and the black of the characters, M. Javel recommends the adoption of a slightly yellow tint of paper. His third suggestion is to give preference to small volumes which can be held in the hand, which obviates the necessity of the book being kept fixed in one place, and lessens the fatigue resulting from accidental images. Lastly, M. Javel advises the avoidance of too long lines, and therefore he prefers small volumes, and for the same reason those journals which are printed in narrow columns. Of course, every one knows that it is exceedingly injurious to read with insufficient light, or to use too small print.

An Insect Ragman.—A correspondent of "Hardwicke's Science Gossip" tells of a very curious discovery he made last summer at Bellosguardo near Florence, viz., a veritable insect ragman. Having noticed what he at first took to be a little nest of spiders' eggs blown along a window-sill, he was led to examine it more closely, and found it to be a rather untidy, fluffy ball, about the size of a large pea; further, that it was moving along of its own accord, stopping now and then for a second, and again resuming its journey. It was soon discovered that the ball of fluff was borne on the back of a little insect somewhat resembling the larva of the *dermestes*, and that the mass was composed of cobweb held on the creature's back by being twisted about in and out among the long hairs on the upper surface of the body. The insect was about one quarter of an inch in length, and bore on its head a pair of forceps about the size of those borne by the common earwig, but its purpose was very different, "for to my amazement," says the author, "I noticed that, each time the creature paused, it was to pick up, with these forceps, some dead ant or portion of a dead insect; and these fragments were picked up so deftly, and in so droll a way did the creature turn its head round and carefully arrange his treasure on his pack, that I was forcibly reminded of the chiffonniers in France and Italy, with their hook and their basket, and of the 'ole clo'' and his pack in England. . . . For more than two days I kept it in a small glass-lidded box, supplied it with 'ole clo',' and watched it constantly collecting and packing; but I never saw it feed, and one morning I found that a large ant I had supposed to be dead had attacked and eaten the creature, scattering the fluffy pack and its contents all over the box." Some weeks after this the author received a note from a friend at Vevey, who from the description recognized the "chiffonnier," two of which, she says, "came toward me, on the table in the garden where I was seated reading, *collecting* and *packing* as you have described." From a friend at Bellosguardo he also, on his return to England, received an account of one she had found, and of which she thus writes: "I had half a mind to send you one of those scavenger or 'ole clo'' insects; but could not arrange anything that would insure its arriving alive. The pack on his back is much less choice than the others, consisting of parts of the bodies of dead flies, spiders' cobwebs, etc., while he himself is much smaller. I feel quite sure it is his food he collects, because the first night I put him under a tumbler he ate the wings of his fly, the only ornamental article in his collection. He is exceedingly fond of sugar—has eaten, I am sure, twice his weight—and has just added two small dead ants to his load, under which he staggers visibly. His pack is held on by long, projecting hairs, and likewise secured and strengthened by cobwebs."

NOTES.

THE Royal Astronomical Society of London has awarded a gold medal to Professor Asaph Hall for "his discovery and observations of the satellites of Mars."

HEINRICH GEISSLER, inventor of sundry ingenious physical apparatus—the Geissler tubes, the vaporimeter, etc.—died January 24th, at Bonn, aged sixty-five years.

PROFESSOR J. LAWRENCE SMITH finds that the native irons of Greenland are mutually similar, and that they differ from the meteoric irons. He thinks it probable that the native iron may have been brought up from below, like the native alloy of platinum and iron.

PROFESSOR DANIEL WILSON, of Toronto, is of the opinion that in the French Canadians there is a liberal infusion of Indian blood. In the neighborhood of Quebec, in the Ottawa Valley, and to a great extent about Montreal, there is, he believes, hardly a family descended from the original settlers who have not some traces of Indian blood. At Ottawa, where the French-Canadian element is strong, the traces of Indian blood are discernible in nearly every individual belonging to that race.

A DILIGENT observer of the ways of animals, Mr. Sidney Buxton, says that dogs and horses are, as far as he knows, the only animals sensitive to ridicule, while cats and birds are wholly unaware that they are being laughed at. Certainly dogs, and probably horses, know the difference between being laughed at in derision, as we laugh at a fool, and being laughed at in admiration, as we laugh at a good comic actor—and enjoy the latter as much as they resent the former. Some parrots, however, seem to understand and enjoy the practice of making fun of their human acquaintances.

IN Switzerland, the men conscripted into the army have to undergo an examination in reading, writing, arithmetic, history, and the geography and political Constitution of Switzerland. At the last examination not a single unlettered conscript was found in thirteen cantons, and the proportion of illiterates exceeded two per cent. in only three cantons, viz., Appenzell, Fribourg, and Valais. In these cantons the illiterates did not exceed four per cent. of the total number of conscripts.

THE London "Lancet" denominates the movement for the cremation of dead bodies a "craze," now that steps have been actually taken to dispose of bodies in that way in England. It questions whether time will ever so completely obliterate the "sense of decency" in the people of England that the notion of burning the dead will be tolerated. To the Lancet, the idea of cremation is "revolting."

IN London the seven weeks ending January 18th was a period of very low temperature, and the Registrar-General, in his reports, institutes a comparison between the mortality of those seven weeks and the seven weeks immediately preceding them. The result shows that the average weekly number of deaths in the cold period exceeded by 481 the average number in the period of moderate temperature, the annual rates of mortality being equal to 26·6 and 19·8 per 1,000 respectively. Among persons under twenty years of age the increased mortality due to cold did not exceed 2·8 per 1,000 living, and the excess between twenty and forty was only 1·3 per 1,000. Between forty and sixty years the excess was 8·7 per 1,000, between sixty and eighty it was 54·4, and among persons over eighty years of age the excess was equal to 173·0 per 1,000 per year.

A CORRESPONDENT of the Hiogo (Japan) "News" writes to that journal that the sect of the *Nishi Honganzi* are erecting several large buildings in the foreign styles near their temples, to be used for school purposes. In addition to the usual Japanese course, English will be taught. The school is intended for educating priests of the sect named, and a select few, when their education is finished, will be sent as apostles and evangelists to Europe and America, to win to the true faith the inhabitants of those benighted regions.

PTERATOMUS PUTNAMII, or "Putnam's winged atom," is the very appropriate name given by Professor Packard to a creature first described by him, and which is probably the smallest of all known insects. An individual of this species was captured last summer by Mr. J. D. COX, who gives a full description of it in the "American Naturalist." Its body is twelve thousandths of an inch in length, the antennæ twenty thousandths. It is probably an egg-parasite of the leaf-cutter bee.

A NEW invention of great interest is announced in "Nature," viz., *a real telegraph*, an instrument with the aid of which one literally writes at a distance. A writer, say at London, moves his pen, and simultaneously at some other point, Brighton for instance, another pen is moved in precisely the same curves and motions. The inventor is E. A. Cowper.

AN International Exhibition, or World's Fair, will be held next August in Sydney, Australia. This announcement is in itself an evidence of the marvelous development of wealth, industry, and refinement among the antipodes.

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